ADM5120P/PX

Network Processor
Version AB

CONFIDENTIAL
Distribution with NDA

Communications

Never stop thinking

Edition 2005-11-09

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CONFIDENTIAL
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	31-Oct-2005: Updated Registers and deleted reference to 200 MHz support
	12-Nov-2005:Updated Table 7-"MII Management"

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1 Product Overview

The following chapter gives an overview of the ADM5120P/PX.

1.1 Overview

ADM5120P/PX is a high performance, highly integrated, and highly flexible SOC (System-On-Chip) that facilitates the combined functions of a SOHO/SME Gateway, NAT Router, Print Server and VPN Gateway in one package. ADM5120P/PX enables the sharing of IP-based broadband services throughout the home/office using wired computers, entertainment equipment, printers, and other intelligent devices.

The ADM5120P/PX is the environmentally friendly 'green' package version.This is in compliance with Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment

Internally, the ADM5120P/PX ASIC consists of a high performance (227 MIPS) embedded MIPS CPU, an embedded switch engine, a 10/100M PHY, an embedded USB host, and interfaces for UART, SDRAM and Flash. The following diagram illustrates a system configuration that uses the supported functions/facilities of ADM5120P/PX

1.2 Features

The following describes the features of the ADM5120P/PX

1.2.1 ASIC Features

Description of ASIC features:

1.2.1.1 Processor

Processor features:

- MIPS 4Kc CPU
- Embedded cache, 8 Kbyte I-cache, 8 Kbyte D-cache
- Embedded memory management unit (MMU) – 32-entry TLB, organized as 16 entry pairs
- 175 MHz/227 MIPS

1.2.1.2 Networking

Networking features:

- 6 ports
- IEEE 802.3 Fast Ethernet
- 5 auto-MDIX (auto-crossover) twisted paired LAN interfaces, embedded 10/100M PHY
- 1 MII interface
- Flexible WAN port selection
- Embedded switch engine
- Embedded Data-buffer/Address-look-up table
- Look-up table read/write-able
- MAC layer security
- MAC clone solution
- MAC filtering, Bandwidth control
- Class of Services (CoS) with two priority levels
- Shared dynamic data buffer management, embedded SSRAM
- Port grouping VLAN (overlap-able)
- TCP/IP accelerator

1.2.1.3 Memory Interface

Memory features:

- SDRAM
- Two bank support (2 chip select pins)
- Each bank can support -- 1M x 32 up to 32M x 32bit (128M-byte)
- Flash
- NOR Flash boot
- NOR Flash: one banks support (1 chip select pin)
- NOR Flash: support – 1M x 8-bit, up to 1M x 32-bit (4M-byte)

1.2.1.4 System

- UART interface
- 4 GPIO pins
- USB 1.1 host
- Clock source
- 25 MHz crystal for 10/100
- 48 MHz crystal for USB
- 0.18 μ CMOS process
- 1.8 V/3.3 V dual power
- PQFP

1.2.2 Software Features

Description of software features:

- Linux/Nucleus Real-Time OS
- Linux-based and Nucleus-based turn key support
- Telnet
- IEEE 802.3 Ethernet Driver
- RS232 Driver for Console User Interface
- DHCP Server/Client
- PPP over Ethernet (PPPoE)
- Network Address Translation (NAT) for IP Address Mapping/Sharing/Security
- DNS Proxy
- Simple Network Time Protocol (SNTP)
- Firewall
- Web-Based Configuration: WEB and HTTP
- TFTP upload/download

1.2.3 Typical Applications

The typical applications of the ADM5120P/PX are:

- IEEE 802.3 SOHO/SME Gateway
- NAT Router
- Print Server (through USB1.1)

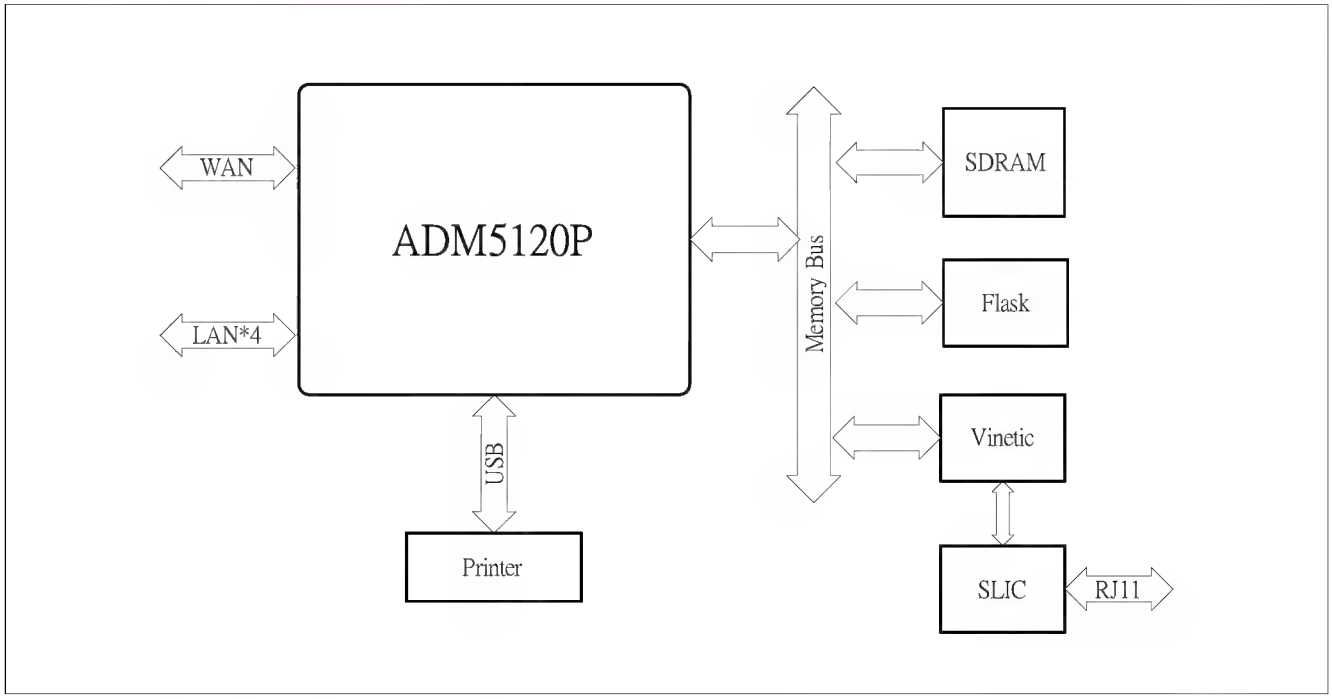


Figure 1 ADM5120P/PX Application

1.3 Conventions

The convention descriptions are described below:

1.3.1 Data Lengths

qword = 64 bits

dword = 32 bits

word = 16 bits

byte = 8 bits

nibble = 4 bits

2 Interface Description

2.1 Pin Description by Function

ADM5120P/PX pins are categorized into one of the following groups:

- **Section 2.1.4, ADM5120P/PX Network Media Connection**
- **Section 2.1.5, Clock for Network**
- **Section 2.1.6, LED**
- **Section 2.1.7, MII Management**
- **Section 2.1.8, Memory Bus**
- **Section 2.1.9, SDRAM Control Signals**
- **Section 2.1.10, UART**
- **Section 2.1.11 JTAG**
- **Section 2.1.12, General Purpose I/O (GPIO)**
- **Section 2.1.13, USB**
- **Section 2.1.14, External CS/INT/Wait**

2.1.1 Section

- **Section 2.1.15, Power and Ground**
- **Section 2.1.16, Regulator Interface**
- **Section 2.1.17, Miscellaneous**

Note: All default settings are 0.

2.1.2 Pin Diagram for P-FQFP-208-10 Package

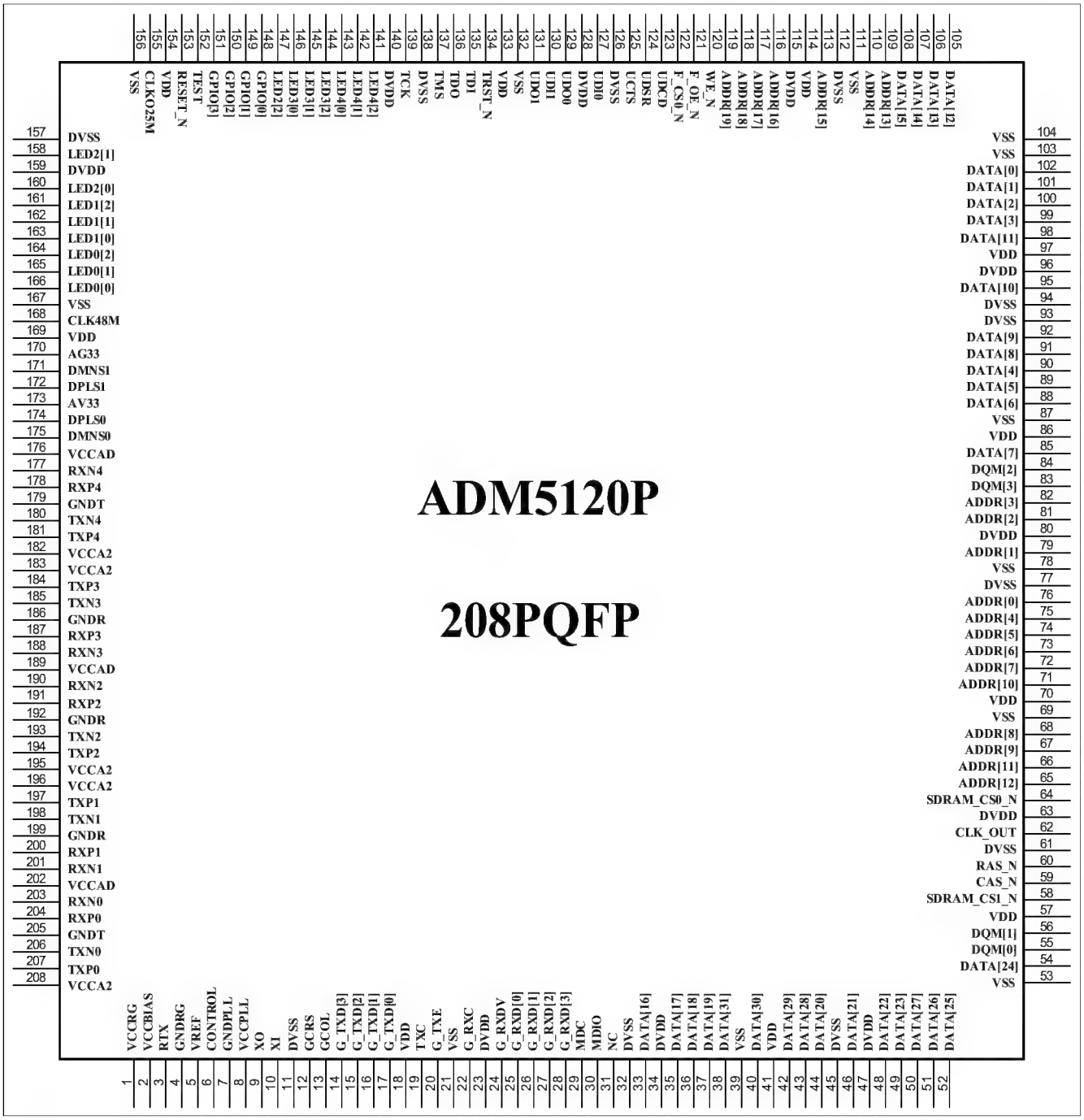


Figure 2 Pin Diagram for P-FQFP-208-10

2.1.3 Abbreviations

Table 1 Abbreviations for Pin Type

Abbreviations	Description
I	Standard input-only pin. Digital levels.
O	Output. Digital levels.
I/O	I/O is a bidirectional input/output signal.
AI	Input. Analog levels.
AO	Output. Analog levels.
AI/O	Input or Output. Analog levels.
PWR	Power
GND	Ground
MCL	Must be connected to Low (JEDEC Standard)
MCH	Must be connected to High (JEDEC Standard)
NU	Not Usable (JEDEC Standard)
NC	Not Connected (JEDEC Standard)

Table 2 Abbreviations for Buffer Type

Abbreviations	Description
Z	High impedance
PU1	Pull up, 10 kΩ
PD1	Pull down, 10 kΩ
PD2	Pull down, 20 kΩ
TS	Tristate capability: The corresponding pin has 3 operational states: Low, high and high-impedance.
OD	Open Drain. The corresponding pin has 2 operational states, active low and tristate, and allows multiple devices to share as a wire-OR. An external pull-up is required to sustain the inactive state until another agent drives it, and must be provided by the central resource.
OC	Open Collector
PP	Push-Pull. The corresponding pin has 2 operational states: Active-low and active-high (identical to output with no type attribute).
OD/PP	Open-Drain or Push-Pull. The corresponding pin can be configured either as an output with the OD attribute or as an output with the PP attribute.
ST	Schmitt-Trigger characteristics
TTL	TTL characteristics
A	Analog Differential pair or Analog PAD

2.1.4 ADM5120P/PX Network Media Connection

Table 3 Network Media Connection

Ball No.	Name	Pin Type	Buffer Type	Function
178	RXP4	AI	A	**Receive Pair** Differential data is received on these pins.
187	RXP3			
191	RXP2			
200	RXP1			
204	RXP0			
177	RXN4			
188	RXN3			
190	RXN2			
201	RXN1			
203	RXN0			
181	TXP4	AO	A	**Transmit Pair** Differential data is transmitted on these pins.
184	TXP3			
194	TXP2			
197	TXP1			
207	TXP0			
180	TXN4			
185	TXN3			
193	TXN2			
198	TXN1			
206	TXN0			

2.1.5 Clock for Network

Table 4 Clock for Network

Ball No.	Name	Pin Type	Buffer Type	Function
9	XOI	O	A	**Crystal Clock Output** 25 MHz crystal output
10	XI	I	A	**External Clock Input** 25 MHz crystal input
3	RTX	I	A	**Reference Voltage**

2.1.6 LED

Table 5 LED

Ball No.	Name	Pin Type	Buffer Type	Function
141	LED4_2	O	PD	**LED 4** LED4_2 state, default = 1010, duplex/colLED4_1 state, default = 0101, speedLED4_0 state, default = 1001, link/activity
142	LED4_1			
143	LED4_0			
144	LED3_2	O	PD	**LED 3** LED3_2 state, default = 1010, duplex/colLED3_1 state, default = 0101, speedLED3_0 state, default = 1001, link/activity
145	LED3_1			
146	LED3_0			
147	LED2_2	O	PD	**LED 2** LED2_2 state, default = 1010, duplex/colLED2_1 state, default = 0101, speedLED2_0 state, default = 1001, link/activity
158	LED2_1			
160	LED2_0			
161	LED1_2	O	PD	**LED 1** LED1_2 state, default = 1010, duplex/colLED1_1 state, default = 0101, speedLED1_0 state, default = 1001, link/activity
162	LED1_1			
163	LED1_0			
164	LED0_2	O	PD	**LED 0** LED0_2 state, default = 1010, duplex/colLED0_1 state, default = 0101, speedLED0_0 state, default = 1001, link/activity
165	LED0_1			
166	LED0_0			

*Note: Registers, not hardware pins, control the LED display. There are 3 LEDs per port, and they can be programmed to any state, the programming information can be found in **Table 6** below.*

Table 6 LED Program

Function	State
GPIO_in (or GPIO_disable)	0000
GPIO_output_flash	0001
GPIO_output_1	0010
GPIO_output_0	0011
Link (steady)	0100
Speed (steady)	0101
Duplex (steady)	0110
Activity (flash)	0111
Collision (flash)	1000
Link+activity	1001
Duplex+collision	1010
10 M_link+activity	1011
100 M_link+activity	1100
Reserved	1101

Table 6 LED Program (cont'd)

Function	State
Reserved	1110
Reserved	1111

2.1.7 MII Management

Table 7 MII Management

Ball No.	Name	Pin Type	Buffer Type	Function
29	MDC	O	PP	**Clock Input MDIO** Runs at a 1 MHz frequency clock for MII port auto-negotiation result monitoring.
14	TXD_3	O		**Transmit Data** All internal pull down. 1. The force speed, duplex & flow control can be set by switch control register (B+14) 2. The reverse MII can only be set by switch control register (B+30)
15	TXD_2			
16	TXD_1			
17	TXD_0			
20	TXE	O		**Transmit Enable** Internal pull down.
24	RXDV	I	TTL/PU	**Receive Data Valid** Internal pull up.
28	RXD_3	I	TTL/PU	**Receive Data** Internal pull up.
27	RXD_2			
26	RXD_1			
25	RXD_0			
22	RXC	I	TTL/PD	**Receive Clock** Internal pull down.
19	TXC	I	TTL/PD	**Transmit Clock** Internal pull down.
12	CRS	I	TTL/PD	**Carrier Sense** Internal pull down.
13	COL	I	TTL/PD	**Collision** Internal pull down.
30	MDIO	BI	PD	**Internal Pull Down** Bi-directional serial pin used to write and read from the registers of the device.

2.1.8 Memory Bus

Table 8 Memory Bus

Ball No.	Name	Pin Type	Buffer Type	Function
38	DATA_31	BI	PD	**Data Bus 31-0** Internal pull down. Data bus for SDRAM, flash memory, and external device.
40	DATA_30			
42	DATA_29			
43	DATA_28			
50	DATA_27			
51	DATA_26			
52	DATA_25			
54	DATA_24			
49	DATA_23			
48	DATA_22			
46	DATA_21			
44	DATA_20			
37	DATA_19			
36	DATA_18			
35	DATA_17			
33	DATA_16			
108	DATA_15			
107	DATA_14			
106	DATA_13			
105	DATA_12			
98	DATA_11			
95	DATA_10			
92	DATA_9			
91	DATA_8			
85	DATA_7			
88	DATA_6			
89	DATA_5			
90	DATA_4			
99	DATA_3			
100	DATA_2			
101	DATA_1			
102	DATA_0			

Table 8 Memory Bus (cont'd)

Ball No.	Name	Pin Type	Buffer Type	Function
119	ADDR_19	O	PD	**Address Bus 19** Address bus for SDRAM, flash memory, and external device. Internal pull down. Pull down = Little Endian. (default)
118	ADDR_18			**Address Bus 18-17** Internal pull down. Can be pulled up and down as following: 00_B boot in 8-bit mode (Flash memory) (default) 01_B boot in 16-bit mode 10_B boot in 32-bit mode 11_B Reserved
117	ADDR_17			
116	ADDR_16			**Address Bus 16-14** Test mode purpose. Normal mode = 000(Default)
113	ADDR_15			
110	ADDR_14			
109	ADDR_13			**Address Bus 13** Default value: 0 0_B PHY separate power on disable 1_B PHY separate power on enable
65	ADDR_12			**Address Bus 12** 0_B BGA package(Default) 1_B 208 PQFP package
66	ADDR_11			**Address Bus 11-5**
71	ADDR_10			
67	ADDR_9			
68	ADDR_8			
72	ADDR_7			
73	ADDR_6			
74	ADDR_5			
75	ADDR_4			**Address Bus 4-3** Can be pulled up and down as following: PLL frequency setting. 00_B 175 MHz (Default) 01_B Reserved $1X_B$ Reserved
82	ADDR_3			
81	ADDR_2			**Address Bus 2** 0_B Enable AutoMDIX 1_B Disable AutoMDIX (Default)
79	ADDR_1			**Address Bus 1** Default value: 0_B 0_B NAND boot disable 1_B NAND boot enable
76	ADDR_0			**Address Bus 0** Default value: 0_B 0_B Normal operation 1_B Simulation mode

2.1.9 SDRAM Control Signals

Table 9 SDRAM Control Signals

Ball No.	Name	Pin Type	Buffer Type	Function
62	CLK_OUT	O	TS	**Clock Out** SDRAM clock, the frequency is set by ADDR_4:3 *Note: 1=pull up, 0=pull down* 00_D 87.5 MHz (Default) 01_D Reserved $1X_B$ Reserved
121	F_OE_N	O	PP	**Output Enable for External Memory** Output enable for external memory banks, active low.
120	WE_N	O	PP	**Write Enable for External Memory** Write Enable for external memory banks and SDRAM.
122	F_CS0_N	O	PP	**Chip Select for External Memory** Chip select for external memory, like flash, bank0, active low.
60	RAS_N	O	PP	**Raw Address Strobe** Raw address strobe, active low.
64	SD_RAM_CS0_N	O	PP	**SDRAM Chip Select 0** SDRAM chip select 0.
59	CAS_N	O	PP	**Column Address Strobe** Column address strobe, active low.
58	SD_RAM_CS1_N	O	PP	**SDRAM Chip Select 1** SDRAM chip select 1.
83	DQM_3	O	PD	**Data Mask Output to SDRAM**
84	DQM_2			
56	DQM_1			
55	DQM_0			

2.1.10 UART

Table 10 UART

Ball No.	Name	Pin Type	Buffer Type	Function
123	UDCD	I	PD	**Data Carrier Detect** UART0 Data carrier detect (modem status input), active low.
124	UDSR			**Data Set Ready** UART0 Data set ready (modem status input), active low.
125	UCTS			**Clear to Send** UART0 clear to send (modem status input), active low.
127	UDI0			**Receive Serial Data Input** UART0 receive serial data input, Internal pull down.
129	UDO0	O		**Transmit Serial Data Output** UART0 transmit serial data output.
130	UDI1	I		**Receive Serial Data Input** UART1 receive serial data input, Internal pull down.
131	UDO1	O		**Transmit Serial Data Output** UART1 transmit serial data output.

2.1.11 JTAG

Table 11 JTAG

Ball No.	Name	Pin Type	Buffer Type	Function
139	TCK	I	PD	**Test Clock** JTAG test clock, Internal pull down.
137	TMS			**Test Mode Select** JTAG test mode select, Internal pull down.
136	TDO	O		**Test Data Out** JTAG test data out.
135	TDI	I		**Test Data In** JTAG test data in, Internal pull down.
134	TRST_N	I	TTL	**Asynchronous Reset** JTAG asynchronous reset (active low).

2.1.12 General Purpose I/O (GPIO)

Table 12 General Purpose I/O (GPIO)

Ball No.	Name	Pin Type	Buffer Type	Function
151	GPIO_3	BI	PD	**BI General Purpose I/O Pin** GPIO_3:0 are internal pull down.
150	GPIO_2			
149	GPIO_1			
148	GPIO_0			

2.1.13 USB

Table 13 USB

Ball No.	Name	Pin Type	Buffer Type	Function
171	DMNS1	BI	A	**Data- of USB Port1** Differential data bus conforming to the USB 1.1.
172	DPLS1			**Data+ of USB Port1** Differential data bus conforming to the USB 1.1.
175	DMNS0			**Data- of USB Port0** Differential data bus conforming to the USB 1.1.
174	DPLS0			**Data+ of USB Port0** Differential data bus conforming to the USB 1.1.
168	CLK48M	I	TTL	**USB Clock Input**

2.1.14 External CS/INT/Wait

Table 14 External CS/INT/Wait

Ball No.	Name	Pin Type	Buffer Type	Function
148	$\overline{\text{WAIT}}$	I	TTL	**WAIT** $\overline{\text{WAIT}}$ is available in switch control register **GPIO_conf2**, bit **CSX0** and **CSX1** and **EW**. When CSX is active and MPMC is programmable then wait_state will time-out, then check the $\overline{\text{WAIT}}$ if high, then complete the access if low, then wait until $\overline{\text{WAIT}}$ goes high.
150	INTX0	I		**External Interrupt Input 0** External interrupt input 0, active high, available if en_csx0_intx0 enable in the switch control register GPIO_config2 (B+BC), bit[4].
149	$\overline{\text{CSX0}}$	O	TS	**External Chip Select 0** External chip select 0, active low, available if en_csx0_intx0 is enabled in the switch control register **GPIO_conf2** bit[4] **CSX0**.
151	$\overline{\text{CSX1}}$	O	TS	**External Chip Select 1** External chip select 1, active low, available if en_csx1_intx1is enabled in the switch control register GPIO_config2 (B+BC), bit[5].

2.1.15 Power and Ground

Table 15 Power and Ground

Ball No.	Name	Pin Type	Buffer Type	Function
18, 41, 57, 70, 86, 97, 114, 133, 154, 169	VDD		A	**Positive Power for Digital Core, 1.8 V**
23, 34, 47, 63, 80, 96, 115, 128, 140, 159	DVDD		A	**Positive Power for I/O, 3.3 V**
182, 183, 195, 196, 208	VDDTS2		A	**Positive Power for Analog Circuitry, 1.8 V**
176, 189, 202	VCCAD		A	**Positive Power for Analog Circuitry, 3.3 V**

Table 15 Power and Ground (cont'd)

Ball No.	Name	Pin Type	Buffer Type	Function
7, 11, 21, 32, 39, 45, 53, 61, 69, 78, 77, 87, 93, 94, 103, 104, 111, 112, 126, 132, 138, 156, 157, 167	VSS		A	**GND for Digital Circuit**
205, 199, 192, 186, 179	VSSA		A	**GND for Analog Circuitry**
8	VCCPLL		A	**Power for Phase Lock Loop, 1.8 V**
1	VCCRG		A	**Power for Regulator, 3.3 V**
2	VCCBIAS		A	**Power for BIAS, 3.3 V**
4	GNDRG		A	**Ground**
173	AV33		A	**Power for USB PHY, 3.3 V**
170	AG33		A	**Power for USB GND**

2.1.16 Regulator Interface

Table 16 Regulator Interface

Ball No.	Name	Pin Type	Buffer Type	Function
5	VREF	AI	A	**Reference Voltage Input** This pin is used as the reference voltage for the regulator and generates the 1.8 V output from the 3.3 V power source.
6	CONTROL	A0	A	**FET Control Output**

2.1.17 Miscellaneous

Table 17 Miscellaneous

Ball No.	Name	Pin Type	Buffer Type	Function
152	TEST	I	TTL/PD	**Test Pin** This pin is for test purposes and should be connected to GND for normal operation.
153	RESET_N	I	TTL	**System Reset** Active low will initialize the chip to default state.
155	CLKO25M	O	PP	**25MHz clock output**
31	NC	NC		**No connection**

3 ADM5120P/PX System

Figure 3 shows the blocks of ADM5120P/PX. The blocks are broken down into:

- MIPS 4Kc
- Multi port memory controller
- USB 1.1 host controller
- UART controller
- Ether switch
  - SW2CPU DMA: this block handles the TX/RX packets from/to the CPU
  - Embedded data buffer
  - Embedded link table/MC table/addr. table
  - 802.3MAC and DMA
- 10/100 DSP PHY

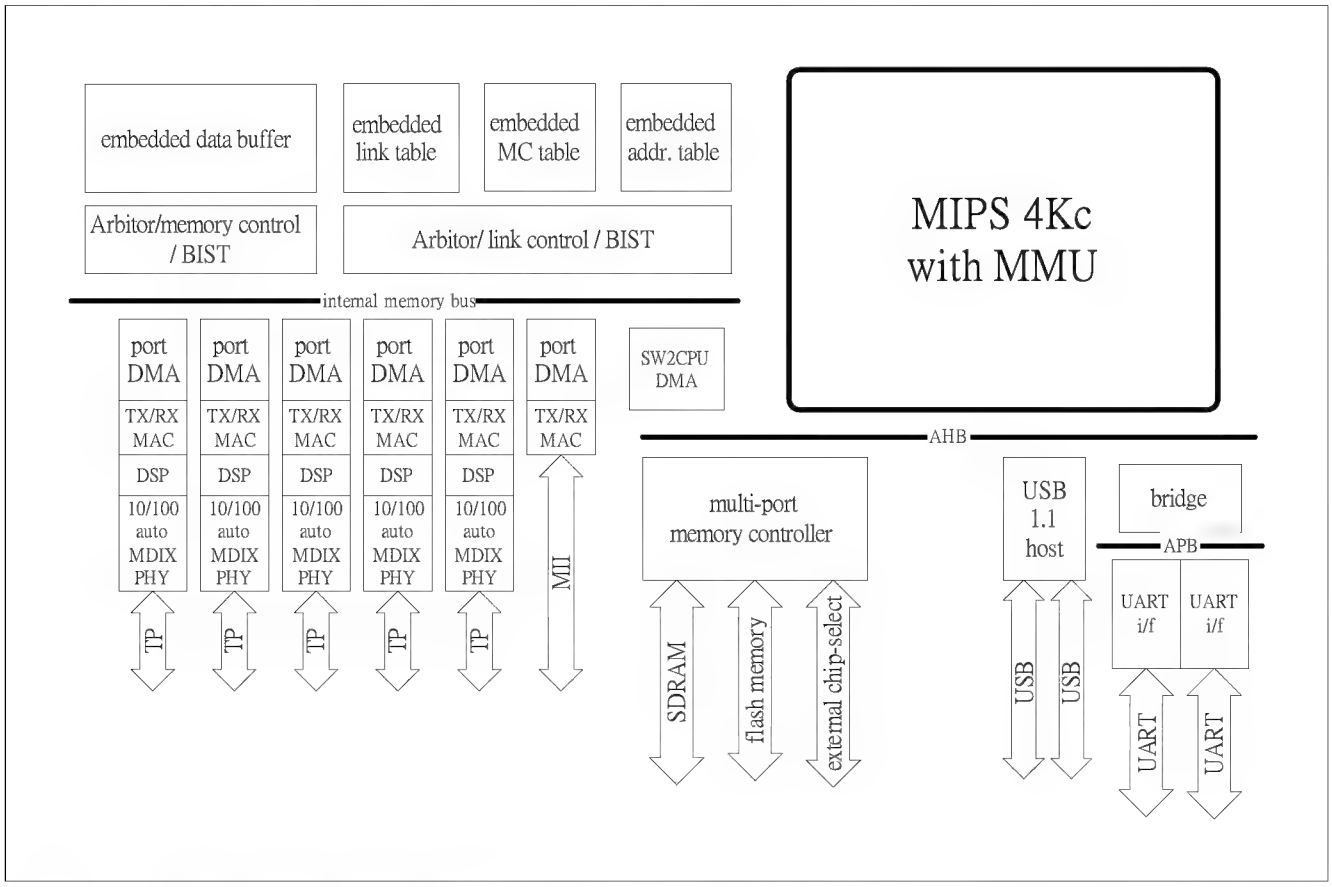


Figure 3 ADM5120P/PX Block Diagram

3.1 System Memory Map

Figure 4 shows the system memory allocation. The following lists a detailed reference for each allocation:

- Boot address is located in SRAM_0, for detailed information refer to **Chapter 5.2.1** Static memory controller
  - The address is fixed at $1FC0\text{-}0000_H$ and the maximum size is 4 Mbyte. The data-width is pin setting and register readable. The size is programmable.
- For external IO, ext_IO_0 and ext_IO_1 are also the generic SRAM space, refer to **Chapter 5.2.1** Static memory controller
- For SRAM_0, ext_IO_0 and ext_IO_1 the address and data width relation are
  - Byte access, address = [20:0], max size = 2 Mbytes

  - 16-bit access, address = [21:1] (shift A0 out), max size = 4 Mbytes
  - 32-bit access, address = [22:2] (shift A0, A1 out), max size = 8 Mbytes
  - Use DQM to select the bytes
- SDRAM_0 is a generic SDRAM space, for detailed information refer to **Chapter 5.2.2** Dynamic memory controller
- MPMC is the Multi Port Memory controller which includes both the Static and the Dynamic memory controller. For detailed information refer to **Chapter 5** MPMC.
- USB 1.1 host controller, refer to the **Chapter 8** USB
- Switch part is Ether Switch which support 6 switch ports and one CPU DMA port. For detailed information refer to **Chapter 6** Switch
- There are two serial ports UART_0 and UART_1, refer to **Chapter 7** UART.
- INTC is an interrupt controller, for detailed information refer to **Chapter 3.2**

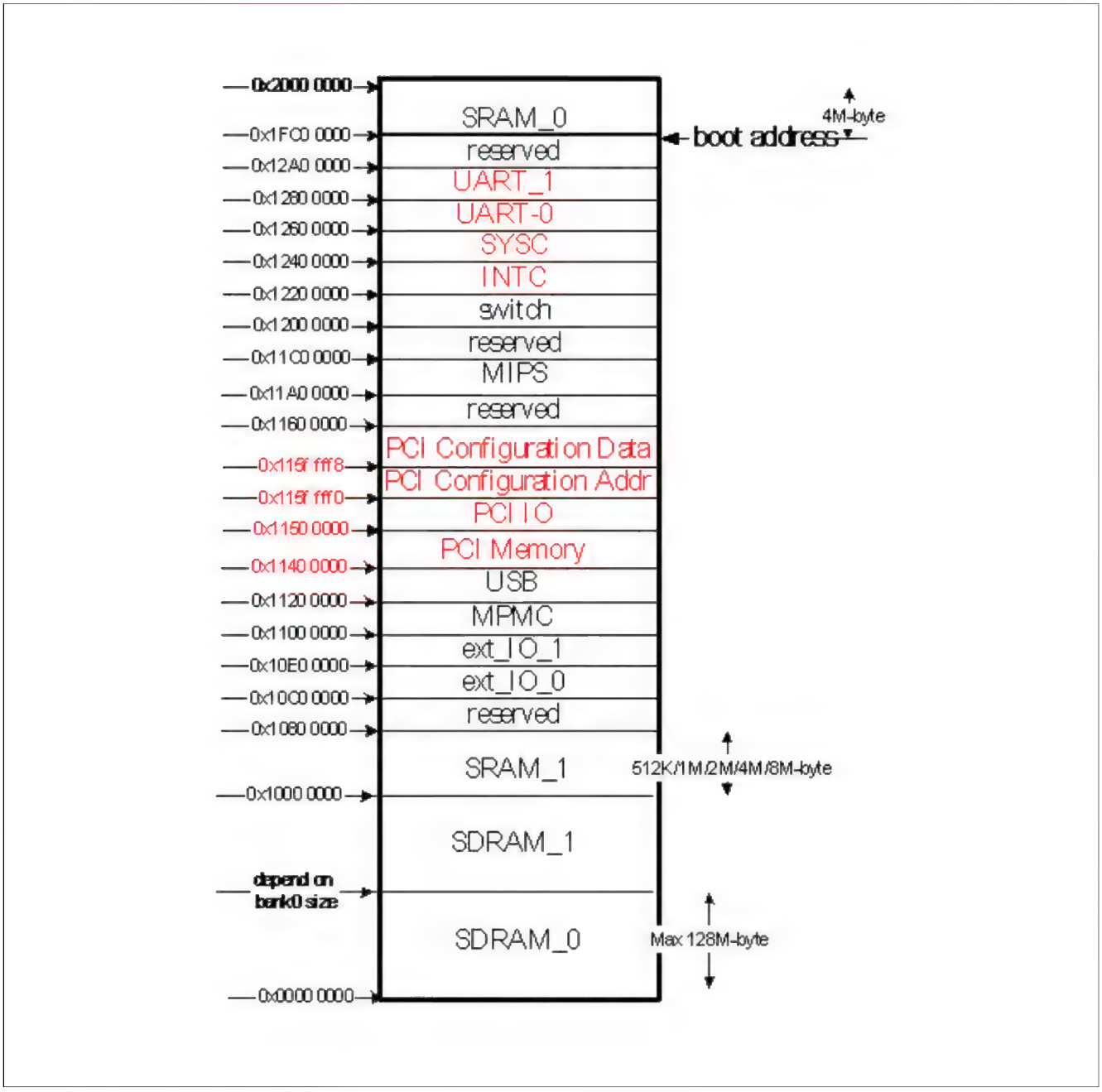


Figure 4 System Memory Map

3.1.1 Memory Mapping Notes

The following describes the memory mapping in detail:

3.2 System and Interrupt Registers Description

The following chapter describes both the system and the interrupt Registers.

Table 18 Registers Address Space

Module	Base Address	End Address	Note
Interrupt Control	1220 0000_H	1220 0024_H	–

Table 19 Registers Overview

Register Short Name	Register Long Name	Offset Address	Page Number
IRQS	Interrupt Request Status	00_H	33
IRQRS	Interrupt Request Raw Status	04_H	34
IRQE	Interrupt Request Enable	08_H	34
IRQEC	Interrupt Request Enable Clear	$0C_H$	35
Res_0	Reserved 0	10_H	36
INT_M	Interrupt Mode	14_H	36
FIQ_S	Fast Interrupt Request Status	18_H	36
IRQ_TS	Interrupt Request Test Source	$1C_H$	37
IRQSS	Interrupt Request Source Sel	20_H	38
INT_L	Interrupt Level	24_H	38

The register is addressed wordwise.

Table 20 Registers Access Types

Mode	Symbol	Description Hardware (HW)	Description Software (SW)
Basic Access Types			
read/write	rw	Register is used as input for the HW	Register is read and writable by SW
read/write virtual	rwv	Physically, there is no new register in the generated register file. The real readable and writable register resides in the attached hardware.	Register is read and writable by SW (same as rw type register)
read	r	Register is written by HW (register between input and output -> one cycle delay)	Value written by SW is ignored by HW; that is, SW may write any value to this field without affecting HW behavior
read only	ro	Same as r type register	Same as r type register
read virtual	rv	Physically, there is no new register in the generated register file. The real readable register resides in the attached hardware.	Value written by SW is ignored by HW; that is, SW may write any value to this field without affecting HW behavior (same as r type register)
write	w	Register is written by software and affects hardware behavior with every write by software.	Register is writable by SW. When read, the register does not return the value that has been written previously, but some constant value instead.
write virtual	wv	Physically, there is no new register in the generated register file. The real writable register resides in the attached hardware.	Register is writable by SW (same as w type register)
read/write hardware affected	rwh	Register can be modified by hardware and software at the same time. A priority scheme decides, how the value changes with simultaneous writes by hardware and software.	Register can be modified by HW and SW, but the priority SW versus HW has to be specified. SW can read the register.

Table 21 Registers Clock Domains

Clock Short Name	Description
–	–

3.2.1 Interrupt Control Register Map

The interrupt controller supports level sensitivity. The external input level can be programmed as active high or low.

Interrupt register description:

Interrupt Request Status

IRQS	Offset	Reset Value
Interrupt Request Status	**00_H**	**0_H**

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res																						**SWI**	Res				**II0**	**UIS**	**UIS1**	**UIS0**	**TI**
																						ro					ro	ro	ro	ro	ro

Field	Bits	Type	Description
Res	31:10		**Reserved**
SWI	9	ro	**Switch Interrupt status after mask** Switch interrupt, refer to switch registers offset 0xB0 and 0xB4 for more detail.
Res	8:5	ro	**Reserved**
II0	4	ro	**Internal Interrupt 0 status after mask** Internal interrupt 0, refer to switch registers offset 0xBC bit[4] for more detail. pin GPIO 2 is the source.
UIS	3	ro	**USB Interrupt Source status after mask**
UIS1	2	ro	**UART1 Interrupt Source status after mask**
UIS0	1	ro	**UART0 Interrupt Source status after mask**
TI	0	ro	**Timer Interrupt status after mask** Timer interrupt, refer to switch registers offset 0xF0 and 0xF4 for more detail.

Interrupt Request Raw Status

IRQRS — **Interrupt Request Raw Status**

Offset 04_H

Reset Value 0_H

31:10	9	8:5	4	3	2	1	0
Res	SWIR	Res	II0R	UISR	UIS*	UIS*	TIR
ro	ro	ro	ro	ro	ro	ro	ro

Field	Bits	Type	Description
Res	31:10	ro	**Reserved**
SWIR	9	ro	**Switch Interrupt Raw status** The Switch interrupt status before masking. refer to switch registers offset 0xB0 and 0xB4 for more detail.
Res	8:5	ro	**Reserved**
II0R	4	ro	**Internal Interrupt 0 Raw status** Internal interrupt 0, refer to switch registers offset 0xBC bit[4] for more detail. pin GPIO 2 is the source.
UISR	3	ro	**USB Interrupt Raw Status**
UIS1R	2	ro	**UART1 Interrupt Raw status**
UIS0R	1	ro	**UART0 Interrupt Raw status**
TIR	0	ro	**Timer Interrupt Raw status** Timer interrupt, refer to switch registers offset 0xF0 and 0xF4 for more detail.

Interrupt Request Enable

IRQE — **Interrupt Request Enable**

Offset 08_H

Reset Value 0_H

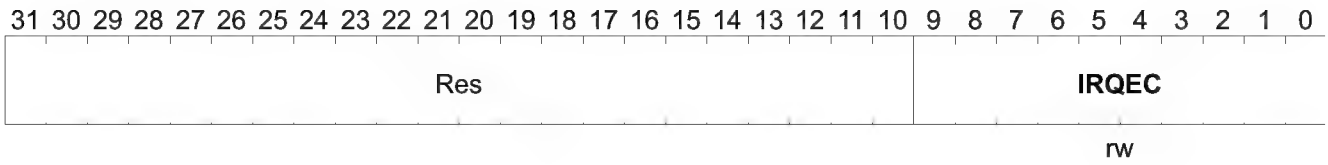
31:10	9	8:5	4	3	2	1	0
Res	SWIE	Res	II0E	UISE	UIS*	UIS*	TIE
ro	rw	rw	rw	rw	rw	rw	rw

Field	Bits	Type	Description
Res	31:10	ro	**Reserved** Not Applicable.

Field	Bits	Type	Description
SWIE	9	rw	**Switch Interrupt Enable** The enable register is used to mask the switch interrupt source. 0_B No effect 1_B Enable the interrupt and allow the interrupt request to MIPS
Res	8:5	rw	**Reserved**
II0E	4	rw	**Internal Interrupt 0 Enable** The enable register is used to mask the GPIO 2 interrupt source. 0_B No effect 1_B Enable the interrupt and allow the interrupt request to MIPS
UISE	3	rw	**USB Interrupt Enable** The enable register is used to mask the USB interrupt source. 0_B No effect 1_B Enable the interrupt and allow the interrupt request to MIPS
UIS1E	2	rw	**UART1 Interrupt Enable** The enable register is used to mask the UART 1 interrupt source. 0_B No effect 1_B Enable the interrupt and allow the interrupt request to MIPS
UIS0E	1	rw	**UART0 Interrupt Enable** The enable register is used to mask the UART 0 interrupt source. 0_B No effect 1_B Enable the interrupt and allow the interrupt request to MIPS
TIE	0	rw	**Timer Interrupt Enable** The enable register is used to mask the Timer interrupt source. refer to B+F0 and B+F4. 0_B No effect 1_B Enable the interrupt and allow the interrupt request to MIPS

Interrupt Request Enable Clear

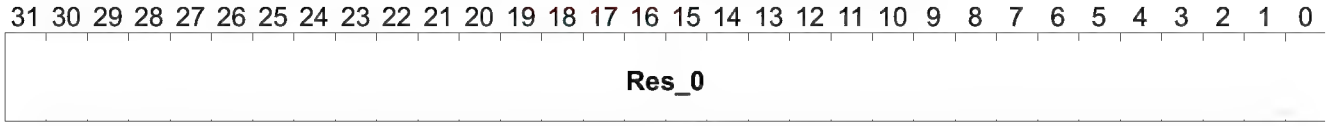
IRQEC	Offset	Reset Value
Interrupt Request Enable Clear	$0C_H$	0_H



Field	Bits	Type	Description
Res	31:10		**Reserved** Not Applicable.
IRQEC	9:0	rw	**IRQ Enable Clear 9:0** This clears the bits of the IRQ_enable. 0_B No effect 1_B Clear the corresponding bit of IRQ_enable

Reserved 0

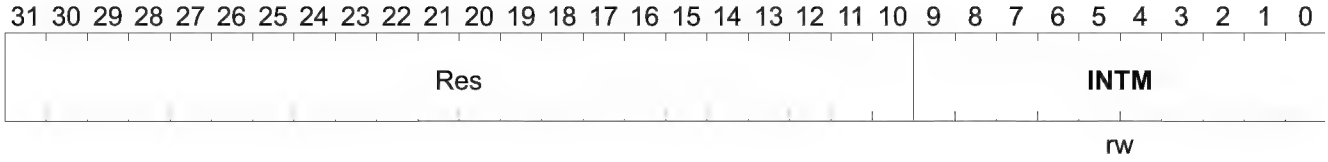
Res_0	Offset	Reset Value
Reserved 0	10_H	0_H



Field	Bits	Type	Description
Res_0	31:0		**Reserved** Not Applicable.

Interrupt Mode

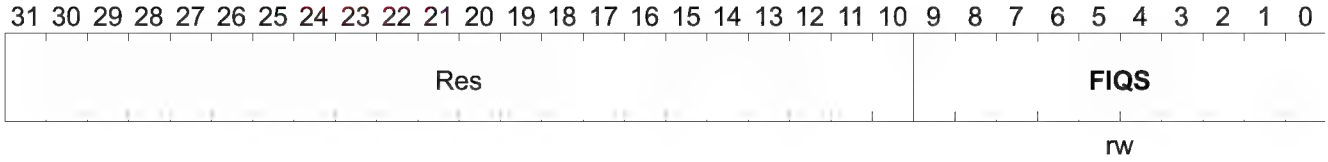
INT_M	Offset	Reset Value
Interrupt Mode	14_H	0_H



Field	Bits	Type	Description
Res	31:10		**Reserved** Not Applicable.
INTM	9:0	rw	**INT Mode 9:0** The interrupt type of the interrupt sources. 0_B The corresponding Interrupt port generates the IRQ to MIPS 1_B The corresponding Interrupt port generates the FIQ to MIPS

Fast Interrupt Request Status

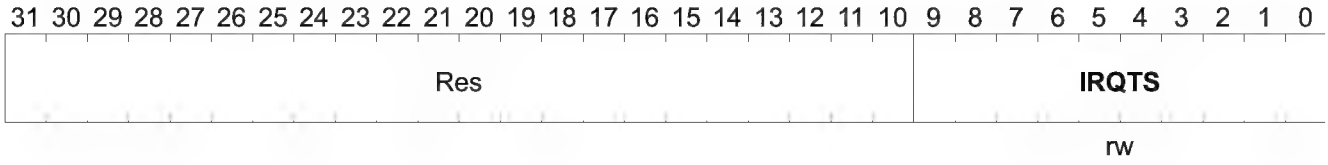
FIQ_S	Offset	Reset Value
Fast Interrupt Request Status	18_H	0_H



Field	Bits	Type	Description
Res	31:10		**Reserved** Not Applicable.
FIQS	9:0	rw	**FIQ Status 9:0** The status of the fast interrupt sources after masking. 1_B The corresponding IRQ is active, and generates the interrupt to MIPS

Interrupt Request Test Source

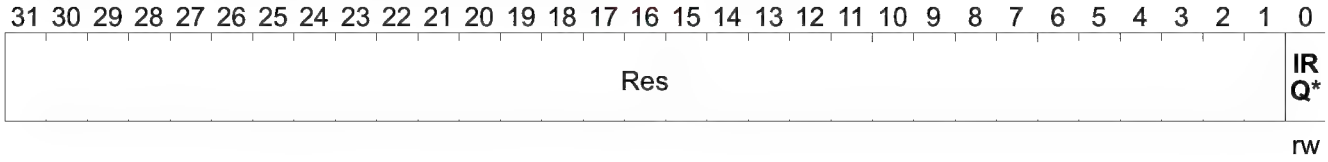
IRQ_TS	Offset	Reset Value
Interrupt Request Test Source	**$1C_H$**	**0_H**



Field	Bits	Type	Description
Res	31:10		**Reserved** Not Applicable.
IRQTS	9:0	rw	**IRQ Test Source 9:0** The test data for the IRQ_raw_status.

Interrupt Request Source Sel

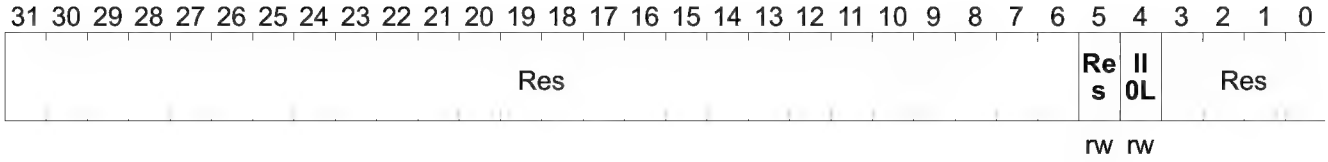
IRQSS	Offset	Reset Value
Interrupt Request Source Sel	20_H	0_H



Field	Bits	Type	Description
Res	31:1		**Reserved** Not Applicable.
IRQSS	0	rw	**IRQ Source Selection** 1_B Load the IRQ_test_source into IRQ_raw_status

Interrupt Level

INT_L	Offset	Reset Value
Interrupt Level	24_H	$1C8_H$



Field	Bits	Type	Description
Res	31:6		**Reserved** Not Applicable.
Res	5	rw	**Reserved** Not Applicable.
II0L	4	rw	**Internal Interrupt 0 Level** Level specify for GPIO 2 interrupt source. 0_B Active high (default) 1_B Active low
Res	3:0		**Reserved** Not Applicable.

4 Main Processor

The CPU description covers:

1. Feature list (**Chapter 4.1**)
2. Functional description (**Chapter 4.2**)

4.1 4Kc CPU Core Features

The 4Kc CPU supports:

- 32-bit Data and Address Paths
- MIPS32™ Compatible Instruction Set
  - All MIPS II™ Instructions
  - Multiply-Add and Multiply-Subtract Instructions (MADD, MADDU, MSUB, MSUBU)
  - Targeted Multiply Instruction (MUL)
  - Zero and One Detect Instructions (CLZ, CLO)
  - Wait Instruction (WAIT)
  - Conditional Move Instructions (MOVZ, MOVN)
  - Prefetch Instructions (PREF)
- MIPS16e Application Specific Extension
  - 16 bit encoding of 32 bit instructions to improve code density
  - Special PC relative instructions for efficient loading of addresses and constants
  - Data type conversion instructions (ZEB, SEB, ZEH, SEH)
  - Compact Jumps (JRC, JALRC)
  - Stack frame set-up and tear down “macro” instructions (SAVE and RESTORE)
- Instruction and Data Cache
  - 8 KByte Instruction Cache Size in a 4-Way set associative organization
  - 4 KByte Data Cache Size in a 2-Way set associative organization
  - Loads that miss in the cache are blocked only until the critical word is available
  - Supports Write-back with write-allocation and Write-through with or without write- allocation
  - 16-byte cache line size, word sectored
  - Virtually indexed, physically tagged
  - Support for cache line locking
  - Non-blocking prefetches
- MIPS32™ privileged resource architecture
  - Count/Compare registers for real-time timer interrupts
  - Instruction and Data watch registers for software breakpoints
  - Separate interrupt exception vector
- Memory Management Unit
  - 16 dual-entry MIPS32 style JTLB with variable page sizes
  - 4-entry instruction micro TLB
  - 4-entry data micro TLB
- Core Bus Interface Unit (Core BIU)
  - All I/Os fully registered
  - Separate, unidirectional 32-bit address and data buses
  - Two 16 Byte collapsing write buffers
- Multiply Divide Unit
  - Maximum issue rate of one 32 x 16 multiply per clock
  - Maximum issue rate of one 32 x 32 multiply every other clock

  - Early-in divide control. Minimum 11, maximum 34 clock cycles
- Power Control
  - No minimum clock frequency
  - Power Down mode (triggered by WAIT instruction)
  - Support for software controlled clock divider
- EJTAG Debug Support
  - CPU control with start, stop and single-step feature
  - Software Breakpoints via SDBBP instruction
  - Hardware Breakpoints on virtual addresses
  - Test Access Port (TAP) facilitates high speed download of application
  - Optional EJTAG Trace hardware to enable real-time tracing of executed code

4.2 Functional Description

The block diagram of the main processor subsystem is given in **Figure 5**.

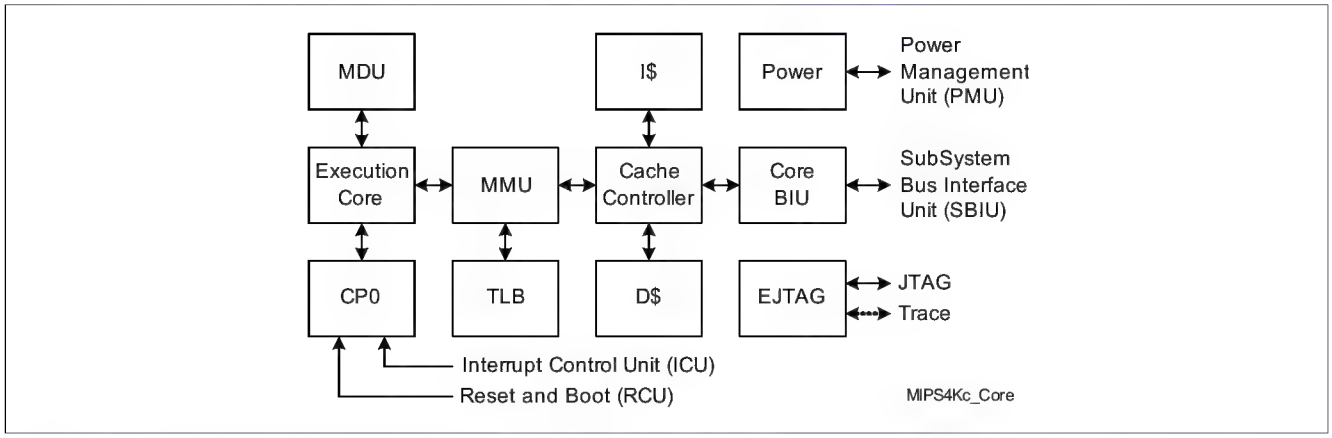


Figure 5 Main Processor Subsystem

The main processor subsystem consists of the below major parts :

- The MMU enabled MIPS 4KC core and associated cache system
- The bus wrapper block translates the MIPS 4Kc EC bus to the system bus

4.2.1 Endianness Mode

The main processor sub-system is capable of running in either big endian or little endian mode. By default, it is set to little endian mode. It can be switched to big endian mode by pin strapping the signal : ADDR[19](Pin 119).

Table 22 Endian Setting

Signal ADDR[19]	Mode
1	Big Endian
0	Little Endian (default)

4.2.2 Coprocessor CP0

In the MIPS architecture, the System Control Coprocessor (CP0) is responsible for the virtual-to-physical address translation, cache protocols, exception control system, processor's diagnostics capability, the operating mode selection (Kernel, Supervisor, User, and Debug) and the enabling/disabling of interrupts. Information such as CPU status, performance and configuration (including caches) are available by accessing the CP0 registers.

4.2.3 Execution Unit

The 4Kc™ core execution unit implements a load/store architecture with single-cycle ALU operations (logical, shift, add, subtract). The 4Kc™ core contains thirty-two 32-bit general-purpose registers used for scalar integer operations and address calculation. The register file consists of two read ports and one write port and is fully bypassed to minimize operation latency in the pipeline.

The execution unit includes:

- 32-bit adder used for calculating arithmetic results and the data addresses
- Address Unit for calculating the next instruction address
- Logic for branch determination and branch target address calculation
- Load aligner
- Bypass multiplexers used to avoid stalls when executing instructions streams where data producing instructions are followed closely by consumers of their results
- Zero/One detect unit for implementing the Count Leading Zero/One (CLZ, CLO) instructions
- Logic unit for performing bitwise logical operations
- Shifter & Store Aligner

4.2.4 Multiply Divide Unit

The multiply divide unit (MDU) performs multiply and divide operations. The pipeline MDU supports execution of a 16:16 or a 32:16 on every clock cycle. 32:32 multiply operations can be issued every other clock cycle. Divide operations are implemented with a 1-bit per clock iterative algorithm and requires 35 clock cycles in worst case to complete. Early-in, the algorithm detects sign extensions of the dividend, reducing the amount of iterations. An attempt to issue subsequent MDU instruction while a divide is still active, causes a pipeline stall until the divide operation is completed.

The MUL instruction specifies that the lower 32 bits of the multiply result is placed in the register file instead of the HI/LO register pair. By avoiding the explicit move from LO (MFLO) instruction, required when using the LO register, and by supporting multiple destination registers, the throughput of multiplication intensive operations is increased.

The multiply add (MADD, MADDU) and multiply subtract (MSUB, MSUBU) are used to perform the multiply add and multiply subtract operations, which are commonly used in Digital Signal Processing (DSP) algorithms.

4.2.5 Memory Management Unit

The Memory Management Unit (MMU) of the MIPS 4Kc™ CPU is implemented as a Translation Lookaside Buffer (TLB). The MMU translates any virtual address to a physical address as well as providing memory protection mechanisms.

The MIPS 4Kc™ CPU supports three operating modes: the User Mode, the Kernel Mode and the Debug Mode. User Mode is often used for application programs. Kernel Mode is typically used for operating system tasks. Debug Mode is used for software debugging purposes.

The address translation performed by the MMU depends on the mode in which the processor is operating. The 4 Gbyte virtual memory space addressed by a 32-bit virtual address is segmented differently depending on the mode of operation (user, kernel, debug). Each of the segments are either mapped or unmapped. Mapped segments use the TLB to translate from virtual to physical addresses, while the unmapped segments have a fixed simple translation.

4.2.6 Cache System

The CPU Core incorporates both on-chip instruction and data caches that can each be accessed in a single processor cycle.

- 8 Kbyte of instruction and an 8 KByte data cache
- Instruction organized as 2-way set associative organization
- Data cache organized as 2-way set associative organization

- Each cache has its own 32-bit data path, both caches can be accessed in the same pipeline clock cycle
- Single processor cycle access
- 16 byte cache line size, word sectored
- Cache locking on a per line basis, CACHE instruction to manipulate the Data and Tag arrays of the instruction as well as the data cache, including cache line locking
- Virtually indexed and physically tagged virtual to physical address translation occurs in parallel with the cache access
- Hit under refill
- Support of streaming instruction or data is forwarded during cache refill
- Non blocking prefetches
- PREF instructions are supported by the data cache controller, which are used to increase the performance by polling the processor
- Non blocking loads
- Supports Write-back with write-allocation and Write-through with or without write- allocation

4.2.7 EJTAG Debug Unit

All cores provide basic EJTAG support with debug mode, run control, single step and software breakpoint instruction (SDBBP) as part of the core. These features allow for the basic software debug of user and kernel code.

Additional EJTAG features include:

- Hardware breakpoints: The hardware instruction breakpoints can be configured to generate a debug exception, when an instruction is executed anywhere in the virtual address space. Bit mask and Address Space Identifier (ASID) values may apply in the address compare. These breakpoints are not limited to code in RAM like the software instruction breakpoint (SDBBP). The data breakpoints can be configured to generate a debug exception on a data transaction. The data transaction may be qualified with both virtual address, data value, size and load/store transaction type. Bit mask and ASID values may apply in the address compare, and byte mask may apply in the value compare.
- A TAP, enabling communication between an EJTAG probe and the CPU through a dedicated port. This provides the possibility for debugging without debug code in the application, and for download of application code to the system.
- An optional block is EJTAG Trace which enables real-time tracing capability. The trace information can be stored to (either an on-chip trace memory, or to) an off-chip trace probe. The trace of program flow is highly flexible and can include instruction program counter as well as data addresses and data values. The trace features provides a powerful software debugging mechanism.

4.3 Register Description

The internal registers are for dug purpose only.

The register description is splitted into Bus Interface Unit (**BIU**) and FPI-Bus 0 (**FB**),

4.3.1 BIU Registers

Absolute Register Address = Module Base Address + Offset Address

Table 23 Module Base Address - BIU

Module Name	Base Address	End Address
BIU	1FA8 0000_H	1FAF $FFFF_H$

Table 24 Registers OverviewRegisters Overview from Chapter BIU Registers

Register Short Name	Register Long Name	Offset Address	Page Number
BIU_ID	Bus Interface Identification Register	0000_H	
BIU_ERRCAUSE	BIU Error Cause Register	0100_H	
BIU_ERR_ADDR	BIU Error Address Register	0108_H	
BIU_AUXI	BIU Auxillary Port Input Register	0200_H	
BIU_AUXO	BIU Auxillary Port Output Register	0208_H	

The register is addressed wordwise.

4.3.1.1

BIU Identification Register

Register **BIU_ID** holds module identification and the revision of the Subsystem BIU module.

BIU_ID	Offset	Reset Value
Bus Interface Identification Register	**0000_H**	**$0000\ 0900_H$**

Field	Bits	Type	Description
ARCH	16	r	**Architecture** This bit identifies if the internal architecture of the logic block is either 64 bit or 32 bit. 0_B **32-bit** internal architecture. 1_B **64-bit** internal architecture.
ID	15:8	r	**Identification Value** This bit field identifies the logic block of the CPU Subsystem. It is used as manufacturer identification code only.
REV	7:0	r	**Revision Number** The first revision starts with 00_H

BIU Access Error Log Register (Error Cause)

The error cause log register holds log information about a detected write error. When the BIU detects an illegal write access the cause of error is logged in this register and its address is logged in the **BIU_ERR_ADDR** register. When the ERR register bit is set, an interrupt is generated to the CPU. While the ERR bit is set no new errors are logged, and new errors are therefore ignored, until this bit has been cleared by the CPU. An illegal address error is reported in the CAUSE field when an access is issued to a reserved memory area, non-existing SRAM memory

or a non-existing register in the BIU or RAM register area. An illegal access error is reported when the BIU detects a non-word access to a defined register area.

Note: Please note that an interrupt is generated if the CPU writes a 1 to the ERR bit. This should only be used for test. For normal operation the CPU will clear this bit in response to hardware setting it.

BIU_ERRCAUSE	Offset	Reset Value
BIU Error Cause Register	0100_H	$0000\ 0000_H$

Field	Bits	Type	Description
ERR	31	rw	**Error log bit** 0_B **No Error** No error logged 1_B **Error logged** Error logged
PORT	19:16	rw	**Port number of the access Initiator** *Note: Others are reserved.* 0_B **CPU** CPU to BIU
CAUSE	1:0	rw	**Error Cause** The CAUSE field indicates the cause of error according to the list below: *Note: Others are reserved.* 00_B **Reset** Reset State 01_B **Illegal address** error caused by Illegal address 11_B **Illegal Access** error caused by Illegal access

Bus Interface Unit Error Address

The accessed address error log register holds the address of a detected write error. When the Subsystem BIU detects an illegal write (e.g. none existing address) the address is logged in this register and the cause of error is logged in the **BIU_ERRCAUSE** register. The register can be written by the CPU but for normal operation the CPU will only read it in response to an error.

BIU_ERR_ADDR	Offset	Reset Value
BIU Error Address Register	0108_H	$0000\ 0000_H$

Field	Bits	Type	Description
ADDR	31:0	rw	**Address of logged illegal access** Returns the illegal address.

Bus Interface Auxillary Port Input

Returns the confirmation that the SIF was flushed.

BIU_AUXI	Offset	Reset Value
BIU Auxillary Port Input Register	0200_H	$0000\ 0000_H$

Field	Bits	Type	Description
ACK	0	r	**SIF Flush ACK** Returns the acknlowdgement that the SIF was flushed. 0_B **No action** 1_B **Flushed** SIF was flushed.

Bus Interface Unit Auxillary Port Output

Used to configure the basic parameters of the BIU.

BIU_AUXO	Offset	Reset Value
BIU Auxillary Port Output Register	0208_H	$0000\ 0000_H$

Field	Bits	Type	Description
max_read_ws	15:8	rw	**Read WS** define number of waitstates for read
Sus	4	rw	**OCDS suspend** should written with 0
Ndt	3	rw	**delayed transaction** should written with 1
Ewa	2	rw	**early_wr_abotr_sup** should written with 0
Era	1	rw	**early_rd_abort_sup** should written with 0
SFR	0	rw	**SIF Flush request** request flush operation from SIF module

4.3.2 FPI Bus Register Description

Absolute Register Address = Module Base Address + Offset Address

Table 25 Module Base Address

Module Name	Base Address	End Address
FB	1F88 0000_H	1F8F $FFFF_H$

Table 26 Registers OverviewRegisters Overview from Chapter FPI Bus Register Description

Register Short Name	Register Long Name	Offset Address	Page Number
FB_ID	FPI Bus Identification Register	0000_H	
FB_ERRCAUSE	FPI Bus Brodge Error Cause Register	0100_H	
FB_ERR_ADDR	FPI Bus Error Address Register	0108_H	
FB_CFG	FPI Bus Bridge Configuration Register	0800_H	

The register is addressed wordwise.

4.3.2.1

FPI Bus Bridge Identification Register

Register **FB_ID** holds information about the FPI-Bus Bridge module.

FB_ID	Offset	Reset Value
FPI Bus Identification Register	**0000_H**	**0000 0800_H**

Field	Bits	Type	Description
ID	15:8	rw	**Identification** Identification number of the FPI Bus Bridge
REV	7:0	rw	**Revision** Indicates the revision of the module. The first revision is 00_H

FPI Bus Error Address

Register **FB_ERR_ADDR** holds the address of a detected write error. When the CPU port of the FPI-Bus Bridge detects an illegal write, the address is logged in register **FB_ERR_ADDR** and the cause of error is logged in register **FB_ERRCAUSE**.

FB_ERR_ADDR	Offset	Reset Value
FPI Bus Error Address Register	**0108_H**	**0000 0000_H**

Field	Bits	Type	Description
ADDR	31:0	rw	**Address of logged illegal access** Resturns the logged illegal address.

FPI Bus Bridge Configuration Register

The FPI Bus bridge configuration register controls the supervisor bit used for the FPI master interface commands. The reset value is SVM = 1, i.e. the FPI-Bus is accessed in Supervisor mode after reset.

FB_CFG	Offset	Reset Value
FPI Bus Bridge Configuration Register	**0800_H**	**$0000\ 0001_H$**

Field	Bits	Type	Description
SVM	0	rw	**Supervisor/User mode** Configures the supervisor/user mode. 0_B **User** operates in User mode 1_B **Supervisor** operates in Supervisor mode

FPI Bus Bridge Access Error log Register (Error Cause)

Register **FB_ERRCAUSE** holds log information about a detected write error. When the CPU port of the FPI-Bus Bridge detects an illegal write, the cause of error is logged in register **FB_ERRCAUSE** and its address is logged in the **FB_ERR_ADDR** register. When the ERR register bit is set, an interrupt to the CPU is issued. While the ERR bit is set, no new errors are logged, hence new errors are ignored until this bit has been cleared by the CPU on write action.

FB_ERRCAUSE	Offset	Reset Value
FPI Bus Brodge Error Cause Register	**0100_H**	**$0000\ 0000_H$**

Field	Bits	Type	Description
ERR	31	rw	**Error log bit** 0_B **No Error** No error logged 1_B **Error** Error logged
PORT	19:16	rw	**Port Number of the Access Initiator** Bit field PORT holds the port number of the access initiator in case of an access error. 0100_B**FPI Bus Bridge** port number of FPI Bus bridge

Field	Bits	Type	Description
CAUSE	1:0	rw	**Error Cause** The CAUSE field indicates the cause of error. 00_B **Reset** Reset State 01_B **Illegal Address** error caused by Illegal address An illegal address error occurs on a write operation outside the address range used for the FPI-Bus Bridge registers 10_B **Illegal Access** error caused by Illegal access An illegal access error occurs on a write operation with illegal byte lane configuration 11_B **Reserved** reserved

5 MultiPort Memory Controller (MPMC)

The MultiPort Memory Controller (MPMC) description covers:

- Feature list (**Chapter 5.1**)
- Functional description (**Chapter 5.2**)
- External Interface; described in the dedicated chapter of the different interfaces
- Registers (**Chapter 5.3**)

5.1 Feature List

The MPMC offers the following features:

- Dynamic memory interface support including SDRAM, JEDEC low-power SDRAM
- Asynchronous static memory device support including SRAM, ROM and NOR Flash with or without asynchronous page mode
- Read and write buffers to reduce latency and to improve performance
- 8-bit, 16-bit and 32-bit wide static memory support
- Static memory features include:
  - Programmable wait states
  - Output enable, and write enable delays
  - Extended wait
  - Bus turnaround delay
  - Asynchronous page mode read
- Controller supports 2K, 4K and 8K row address synchronous memory parts. That is typical 512M, 256M, 128M and 16MB parts with 8, 16 or 32DQ bits per device.

5.2 Functional Description

The following describes the MPMC's functions

5.2.1 Static Memory Controller

Static memory descriptions:

5.2.1.1 Extended Wait Transfers

The static memory controller supports extremely long transfer times. In normal use the memory transfers are timed using the **MPMC Static Wait Rd 1** and **MPMC Static Wait Wr 1** registers. These registers enable transfers with up to 32 wait states. However, if an extremely slow static memory device has to be accessed you can enable the Extended Wait(EW) bit in register . When this bit is enabled the **MPMC Static Extended Wait** register is used to time both the read and write transfers. This register enables transfers to have up to 16368 wait states.

5.2.1.2 Wait State Generation

Each bank of the MPMC must be configured for external transfer wait states in read and write accesses. This is achieved by programming the appropriate fields of the bank control registers:

- **MPMC Static Wait Wen 1**
- **MPMC Static Wait Oen 1**
- **MPMC Static Wait Rd 1**
- **MPMC Static Wait Wr 1**
- **MPMC Static Wait Page 1**
- **MPMC Static Wait Turn 1**
- **MPMC Static Extended Wait**

The number of cycles in which an AMBA transfer completes is controlled by two additional factors:

- Access width
- External memory width

5.2.1.3 Static Memory Read Control

The static memory read controls are described in the following:

- The delay between the assertion of the chip select and the output enable is programmable from 0 to 15 cycles using the WAITOEN bits of the **MPMC Static Wait Oen 1** registers. The output enable is always deasserted at the same time as the chip select, at the end of the transfer. **Figure 6** shows that the WAIOEN is set to 2 in the **MPMC Static Wait Oen 1** registers.
- The read access time is determined by the number of wait states programmed for the WAITRD field of the **MPMC Static Wait Rd 1** register. The WAITTURN field in the **MPMC Static Wait Turn 1** register determines the minimum number of bus turnaround wait states added between external read and write transfers. **Figure 7** shows that the WAITRD is set to 2 in the **MPMC Static Wait Rd 1** register.
- The MPMC supports asynchronous page mode read up to four memory transfers by updating address bits A[1] and A[0]. This feature increases the bandwidth by using a reduced access time for the read accesses that are in page mode. The first read access takes **MPMC Static Wait Rd 1** and WAITRD cycles. Subsequent read accesses that are in page mode take **MPMC Static Wait Page 1** and WAITPAGE cycles. The chip select and output enable lines are held during the burst, and only the lower two address bits change between subsequent accesses. At the end of the burst the chip select and output enable lines are deasserted together. The **Figure 8** shows the page mode read with 2 WAITRD cycles and 1 WAITPAGE cycle.

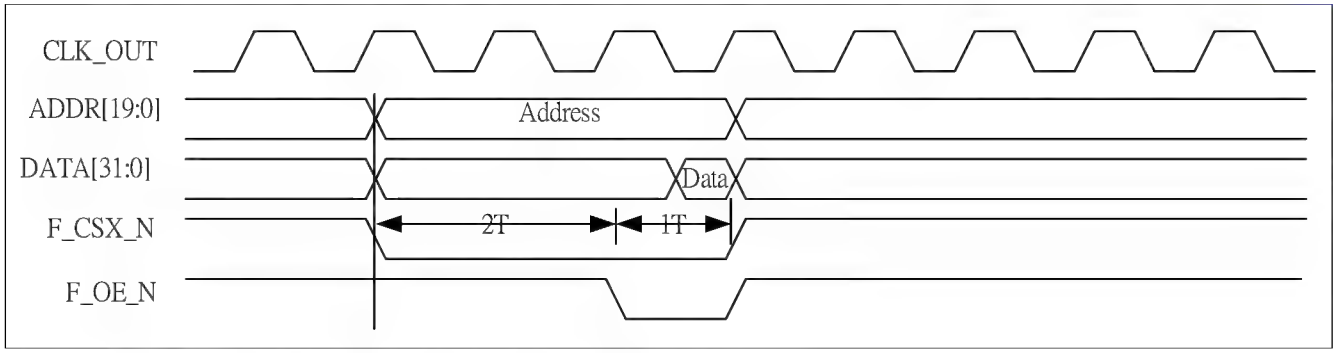


Figure 6 Read with Two Clock Delay for Read Enable

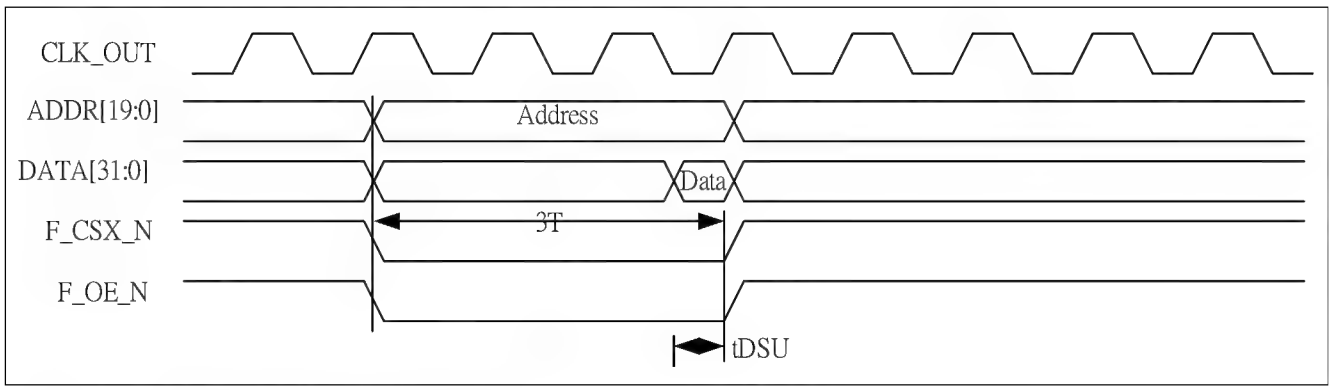


Figure 7 Read with Two Wait State

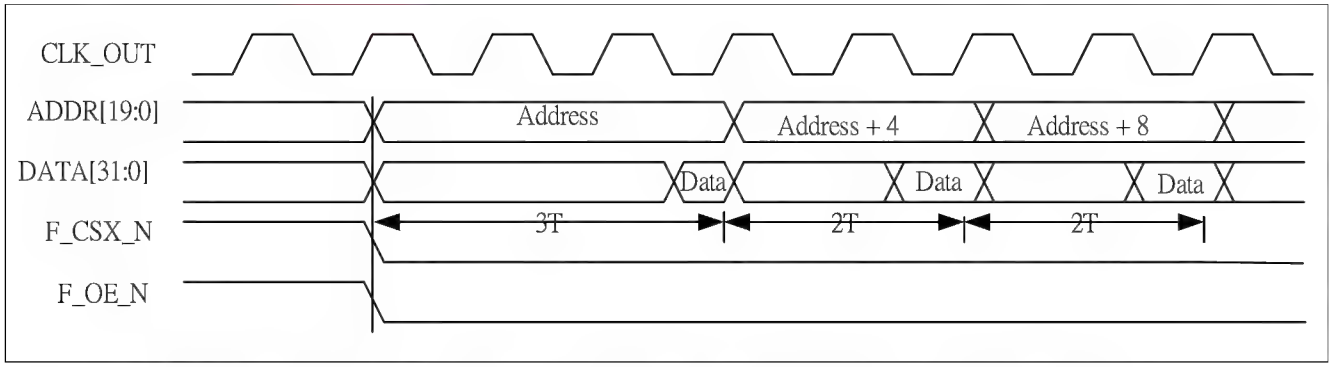


Figure 8 Asynchronous Page Mode Read with 2 Wait State and 1 Sequential Wait State

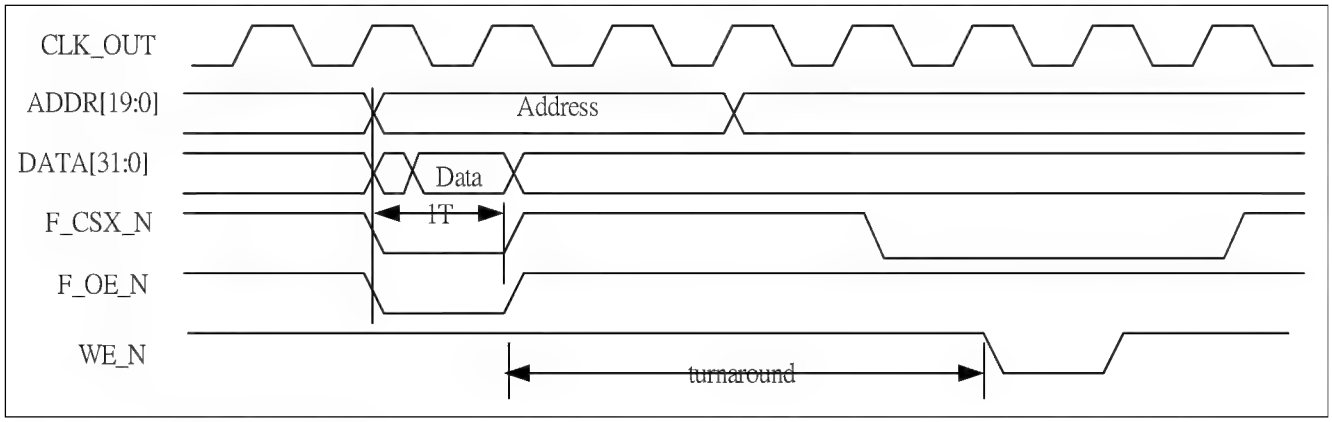


Figure 9 Bus Turnaround

5.2.1.4 Static Memory Write Control

Write timing is described in the following:

- The delay between the assertion of the chip select and the write enable is programmable from 0 to 15 cycles using the WAITWEN bits of the **MPMC Static Wait Wen 1** registers. The write enable is asserted on the rising edge of MPMCCLK after the assertion of the chip select for the zero wait state. The write enable is always deasserted a cycle before the chip select, at the end of the transfer.
- The write access time is determined by the number of wait states programmed for the WAITWR field of the **MPMC Static Wait Wr 1** register. The WAITTURN field in the **MPMC Static Wait Turn 1** register determines the number of bus turnaround wait states added between external read and write transfers.

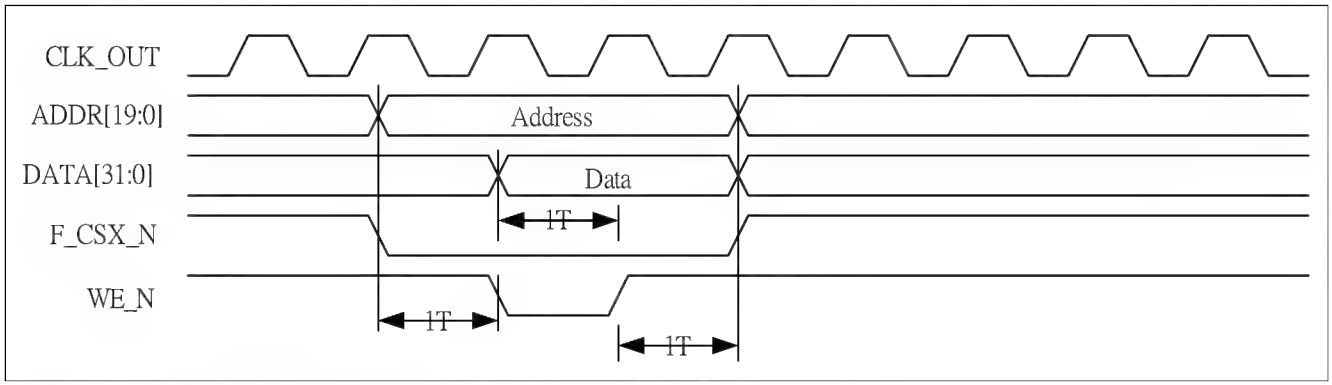


Figure 10 Write with Zero Wait State

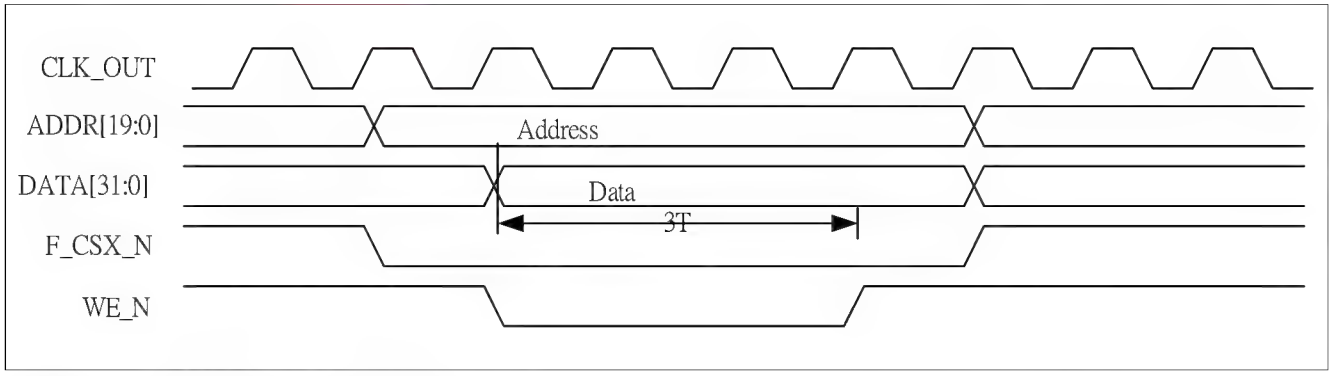


Figure 11 Write with Two Wait State

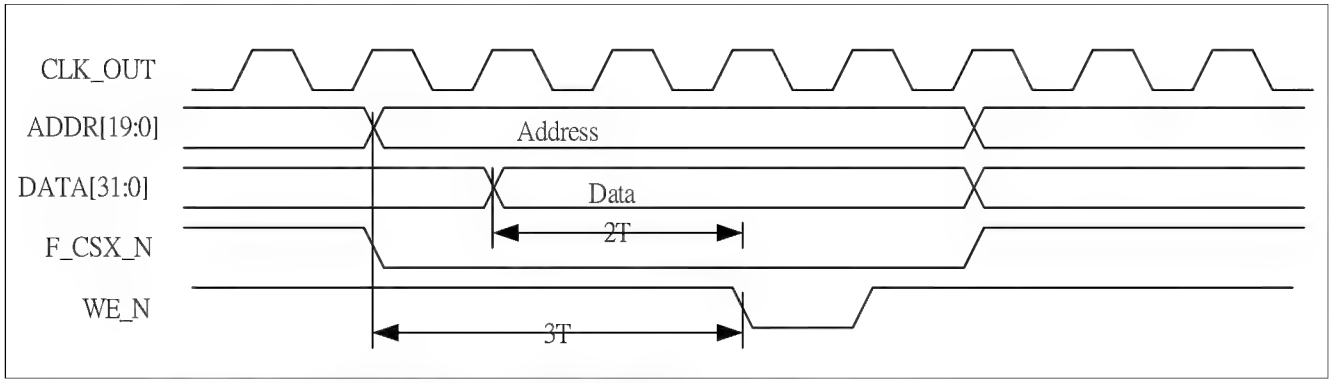


Figure 12 Write with Two Clock Delay for Write Enable

5.2.2 Dynamic Memory Controller

The following describes the Dynamic Controller.

5.2.2.1 Dynamic Memory Controller Command Descriptions

The dynamic memory controller block in MPMC supports the SDRAM memory commands shown in list below:

- ACT: Opens an SDRAM row
- REF: CAS before RAS style refresh
- SREF: self-refresh
- PRE: Pre-charge, close a bank
- RD: Read from an open row, row left open
- WR: Write to an open row, row left open
- RDA: Read followed by pre-charge
- WRA: Write followed by pre-charge

The commands listed above are generated automatically.

The commands in the list below are generated under software control by programming the SDRAM initialization and deep sleep mode fields of the **MPMC Dynamic Control** register.

- MRS: Mode register set, programs SDRAM mode register
- NOP: No operation, used during the SDRAM initialization sequence
- PALL: Pre-charge all, used during the SDRAM initialization sequence
- DSM: Deep sleep mode, for low-power SDRAM

5.2.2.2 Generic SDRAM Initialization Example

On power-on reset, software must initialize the MPMC and each of the dynamic memories connected to the controller. Check the dynamic memory data sheet for the start up procedure. A generic example initialization sequence is shown below:

- Wait 100 ms after the power is applied and the clocks have stabilized.
- Set the SDRAM Initialization (I) value to NOP in the **MPMC Dynamic Control** register. This automatically issues a NOP command to the SDRAM memories.
- Wait 200 ms.
- Set the SDRAM Initialization (I) value to PALL in the **MPMC Dynamic Control** register. This automatically issues a pre-charge all instruction (PRE-ALL) to the SDRAM memories. This pre-charges all banks and places the device into the all banks idle state.
- Perform a number of refresh cycles, by writing 1 into the refresh register, **MPMC Dynamic Refresh**. This provides a memory refresh every 16 AHB clock cycles.
- Wait until eight SDRAM refresh cycles have occurred (128 AHB clock cycles)
- Program the operational value into the refresh register, **MPMC Dynamic Refresh**
- Program the operational value into the latency register, **MPMC Dynamic RAS**
- Program the operational values into the configuration register, **MPMC Dynamic Config 0**. The buffers must be disabled during initialization.
- Set the SDRAM initialization value (I) to MODE in the **MPMC Dynamic Control** register.
- Program the SDRAM memories mode register. The mode register enables the following parameters to be programmed.
  - Burst length
  - Burst type
  - CAS latency
  - Operating mode
  - Write burst mode
- Set the SDRAM initialization value (I) to NORMAL in the **MPMC Dynamic Control** register.
- Enable the buffers in the **MPMC Dynamic Config 0** configuration register. The SDRAM is now ready for normal operation.

5.3 MPMC Registers Description

The below describes the MPMC registers in great detail.

Note: For ALL Reserved Registers please note: Read is defined and all must be written as zeros.

5.3.1 MPMC Registers

Table 27 Registers Address Space

Module	Base Address	End Address	Note
MPMC	$1100\ 0000_H$	$1100\ 0278_H$	

Table 28 Registers Overview

Register Short Name	Register Long Name	Offset Address	Page Number
MPMC_C	MPMC Control	000_H	57
MPMC_S	MPMC Status	004_H	57
MPMC_Conf	MPMC Configuration	008_H	59
MPMC_DC	MPMC Dynamic Control	020_H	60
MPMC_DR	MPMC Dynamic Refresh	024_H	61
MPMC_DRP	MPMC Dynamic RP	030_H	62
MPMC_DRAS	MPMC Dynamic RAS	034_H	62
MPMC_DSREX	MPMC Dynamic SREX	038_H	62
MPMC_DAPR	MPMC Dynamic APR	$03C_H$	64
MPMC_DDAL	MPMC Dynamic DAL	040_H	64
MPMC_DWR	MPMC Dynamic WR	044_H	64
MPMC_DRC	MPMC Dynamic RC	048_H	66
MPMC_DRFC	MPMC Dynamic RFC	$04C_H$	66
MPMC_DXSR	MPMC Dynamic XSR	050_H	66
MPMC_DRRD	MPMC Dynamic RRD	054_H	68
MPMC_DMRD	MPMC Dynamic MRD	058_H	68
MPMC_SEW	MPMC Static Extended Wait	080_H	68
MPMC_DC0	MPMC Dynamic Config 0	100_H	70
MPMC_DRC0	MPMC Dynamic Ras Cas 0	104_H	74
MPMC_DC1	MPMC Dynamic Config 1	120_H	73
MPMC_DRC1	MPMC Dynamic Ras Cas 1	124_H	75
MPMC_SC1	MPMC Static Config 1	220_H	76
MPMC_SWW1	MPMC Static Wait Wen 1	224_H	82
MPMC_SWO1	MPMC Static Wait Oen 1	228_H	85
MPMC_SWR1	MPMC Static Wait Rd 1	$22C_H$	88
MPMC_SWP1	MPMC Static Wait Page 1	230_H	91
MPMC_SWWR1	MPMC Static Wait Wr 1	234_H	94
MPMC_SWT1	MPMC Static Wait Turn 1	238_H	97
MPMC_SC2	MPMC Static Config 2	240_H	78
MPMC_SWW2	MPMC Static Wait Wen 2	244_H	83

Table 28 Registers Overview (cont'd)

Register Short Name	Register Long Name	Offset Address	Page Number
MPMC_SWO2	MPMC Static Wait Oen 2	248_H	86
MPMC_SWR2	MPMC Static Wait Rd 2	$24C_H$	89
MPMC_SWP2	MPMC Static Wait Page 2	250_H	92
MPMC_SWWR2	MPMC Static Wait Wr 2	254_H	95
MPMC_SWT2	MPMC Static Wait Turn 2	258_H	98
MPMC_SC3	MPMC Static Config 3	260_H	80
MPMC_SWW3	MPMC Static Wait Wen 3	264_H	84
MPMC_SWO3	MPMC Static Wait Oen 3	268_H	87
MPMC_SWR3	MPMC Static Wait Rd 3	$26C_H$	90
MPMC_SWP3	MPMC Static Wait Page 3	270_H	93
MPMC_SWWR3	MPMC Static Wait Wr 3	274_H	96
MPMC_SWT3	MPMC Static Wait Turn 3	278_H	99

The register is addressed wordwise.

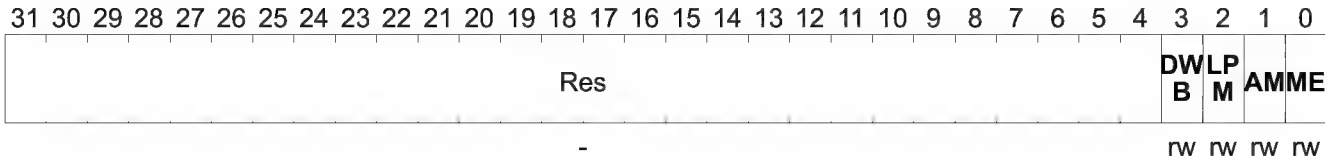
Table 29 Registers Access Types

Mode	Symbol	Description Hardware (HW)	Description Software (SW)
Basic Access Types			
read/write	rw	Register is used as input for the HW	Register is read and writable by SW
read/write virtual	rwv	Physically, there is no new register in the generated register file. The real readable and writable register resides in the attached hardware.	Register is read and writable by SW (same as rw type register)
read	r	Register is written by HW (register between input and output -> one cycle delay)	Value written by SW is ignored by HW; that is, SW may write any value to this field without affecting HW behavior
read only	ro	Same as r type register	Same as r type register
read virtual	rv	Physically, there is no new register in the generated register file. The real readable register resides in the attached hardware.	Value written by SW is ignored by HW; that is, SW may write any value to this field without affecting HW behavior (same as r type register)
write	w	Register is written by software and affects hardware behavior with every write by software.	Register is writable by SW. When read, the register does not return the value that has been written previously, but some constant value instead.
write virtual	wv	Physically, there is no new register in the generated register file. The real writable register resides in the attached hardware.	Register is writable by SW (same as w type register)
read/write hardware affected	rwh	Register can be modified by hardware and software at the same time. A priority scheme decides, how the value changes with simultaneous writes by hardware and software.	Register can be modified by HW and SW, but the priority SW versus HW has to be specified. SW can read the register.

5.3.1.1 Registers Description

MPMC Control

MPMC_C	Offset	Reset Value
MPMC Control	000_H	1_H



Field	Bits	Type	Description
Res	31:4	-	**Not applicable**
DWB	3	rw	**Drain Write Buffers** 0_B Buffers operate normally (reset value on nPOR, and HRESETn) 1_B Drain write buffers.
LPM	2		**Low-Power Mode** Indicate normal, or low-power mode. Entering low-power mode reduces memory controller power consumption. Dynamic memory is refreshed as necessary. The memory controller returns to normal function mode by clearing the low-power mode bit (L), or by system, or power-on reset. 0_B Normal mode (reset value on nPOR, and HRESETn) 1_B Low-power mode.
AM	1		**Address Mirror** Indicates normal or reset memory map. Static memory chip select 1 is mirrored onto chip select 0 and chip select 4 (reset value on nPOR). On power-on reset, chip select 1 is mirrored to both chip select 0 and chip select 1 and chip 4 memory areas. Clearing the M bit enables chip select 0 and chip select 4 memory to be accessed. 0_B Normal memory map 1_B Reset memory map.
ME	0		**MPMC Enable** Indicates if the PrimeCell MPMC is enabled or disabled. Disabling the PrimeCell MPMC reduces power consumption. When the memory controller is disabled the memory is not refreshed. The memory controller is enabled by setting the enable bit, or by system, or power-on reset. 0_B Disabled 1_B Enabled (reset value on nPOR, and HRESETn).

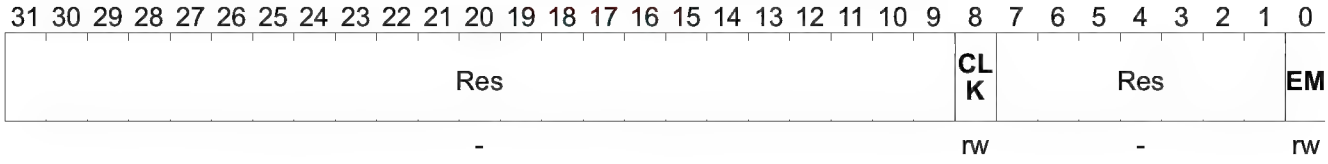
MPMC Status

MPMC_S	Offset	Reset Value
MPMC Status	004_H	0_H

Field	Bits	Type	Description
Res	31:3		**Reserved** Not applicable
SRA	2	r	**Self-Refresh Acknowledge** This read only bit indicates the operating mode of the MPMC. 0_B Normal mode (reset value on nPOR) 1_B Self-refresh acknowledge.
WBS	1		**Write Buffer Status** This read only bit enables the PrimeCell MPMC to enter low-power mode or disabled mode cleanly. 0_B Write buffers empty (reset value on nPOR) 1_B Write buffers contain data.
BU	0		**Busy** This read-only bit is used to ensure that the memory controller enters the low-power or disabled mode cleanly. 0_B MPMC is idle (reset value on nPOR, and HRESETn) 1_B MPMC is busy performing memory transactions.

MPMC Configuration

MPMC_Conf	Offset	Reset Value
MPMC Configuration	008_H	0_H



Field	Bits	Type	Description
Res	31:9	-	**Reserved** Read undefined, must be written as zeros.
CLK	8	rw	**Clock Ratio** HCLK: MPMCCLKOUT3:0 ratio. 0_B 1:1 (reset value on nPOR) 1_B 1:2.
Res	7:1	-	**Reserved** Read undefined, must be written as zeros.
EM	0	rw	**Endian Mode** The value of the endian bit on power-on-reset (nPOR) is determined by the MPMCBIGENDIAN signal. This value can be overridden by software. This field is unaffected by the AHB reset (HRESETn). 0_B Little-endian mode 1_B Big-endian mode.

MPMC Dynamic Control

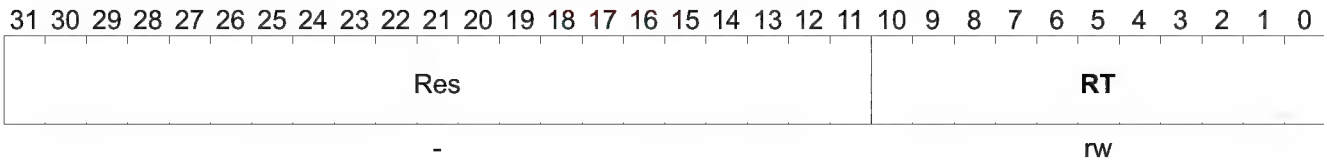
MPMC_DC	Offset	Reset Value
MPMC Dynamic Control	020_H	2_H

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res																		DSM	Res				SI		Res				SRR	DMC	CE	
-																		rw	-				rw		-				rw	rw	rw	

Field	Bits	Type	Description
Res	31:14	-	**Reserved** Read undefined. Must be written as zeros.
DSM	13	rw	**Low-Power SDRAM Deep Sleep Mode** 0_B Normal operation (reset value on nPOR) 1_B Enter deep power down mode.
Res	12:9	-	**Reserved** Read undefined. Must be written as zeros.
SI	8:7	rw	**SDRAM Initialization** 00_B Issue SDRAM NORMAL operation command (reset value on nPOR) 01_B Issue SDRAM MODE command 10_B Issue SDRAM PALL (precharge all) command 11_B Issue SDRAM NOP (no operation) command.
Res	6:3	-	**Reserved** Read undefined. Must be written as zeros.
SRR	2	rw	**Self-Refresh Request (SR)** By writing 1 to this bit self-refresh can be entered under software control. Writing 0 to this bit returns the MPMC to normal mode. The self-refresh acknowledge bit in the MPMCStatus register must be polled to discover the current operating mode of the MPMC. 0_B Normal mode (reset value on nPOR) 1_B Enter self-refresh mode.
DMC	1	rw	**Dynamic Memory Clock Control** When clock control is LOW the output clock MPMCCLKOUT is stopped when there are no SDRAM transactions. The clock is also stopped during self-refresh mode. 0_B MPMCCLKOUT stops when all SDRAMs are idle and during self-refresh mode 1_B MPMCCLKOUT runs continuously (reset value on nPOR).
CE	0	rw	**Dynamic Memory Clock Enable** 0_B Clock enable of devices are deasserted to save power (reset value on nPOR) 1_B All clock enables are driven HIGH continuously.

MPMC Dynamic Refresh

MPMC_DR	Offset	Reset Value
MPMC Dynamic Refresh	024_H	0_H

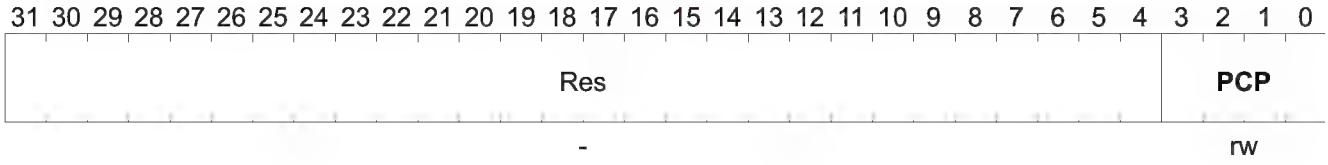


Field	Bits	Type	Description
Res	31:11	-	**Reserved** Read undefined. Must be written as zeros.
RT	10:0	rw	**Refresh Timer** 0_D Refresh disabled (reset value on nPOR) 1_D 16 HCLK ticks between SDRAM refresh cycles $\cdots_D$ n_D n x16 HCLK ticks between SDRAM refresh cycles.

MPMC Dynamic RP

Note: The delay is in MPMCCLK cycles.

MPMC_DRP	Offset	Reset Value
MPMC Dynamic RP	030_H	F_H

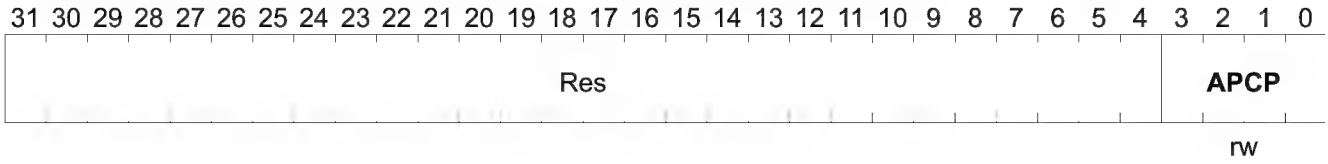


Field	Bits	Type	Description
Res	31:4	-	**Reserved** Read undefined. Must be written as zeros.
PCP	3:0	rw	**Precharge Command Period** 0_H 1 clock cycle ...H F_H 16 clock cycles (reset value on nPOR)

MPMC Dynamic RAS

Note: The delay is in MPMCCLK cycles.

MPMC_DRAS	Offset	Reset Value
MPMC Dynamic RAS	034_H	F_H

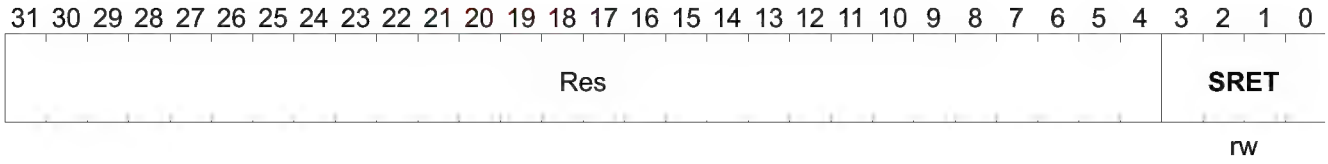


Field	Bits	Type	Description
Res	31:4		**Reserved** Read undefined. Must be written as zeros.
APCP	3:0	rw	**Active to Precharge Command Period** 0_H 1 clock cycle ...H F_H 16 clock cycles (reset value on nPOR)

MPMC Dynamic SREX

Note: The delay is in MPMCCLK cycles.

MPMC_DSREX	Offset	Reset Value
MPMC Dynamic SREX	038_H	F_H



Field	Bits	Type	Description
Res	31:4		**Reserved** Read undefined. Must be written as zeros.
SRET	3:0	rw	**Self-Refresh Exit Time** 0_H 1 clock cycle ...H F_H 16 clock cycles (reset value on nPOR)

MPMC Dynamic APR

Note: The delay is in MPMCCLK cycles.

MPMC_DAPR	Offset	Reset Value
MPMC Dynamic APR	$03C_H$	F_H

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res																												LACT			
-																												rw			

Field	Bits	Type	Description
Res	31:4	-	**Reserved** Read undefined. Must be written as zeros.
LACT	3:0	rw	**Last-Data-Out to Active Command Time** 0_H 1 clock cycle ...H F_H 16 clock cycles (reset value on nPOR)

MPMC Dynamic DAL

Note: The delay is in MPMCCLK cycles.

MPMC_DDAL	Offset	Reset Value
MPMC Dynamic DAL	040_H	F_H

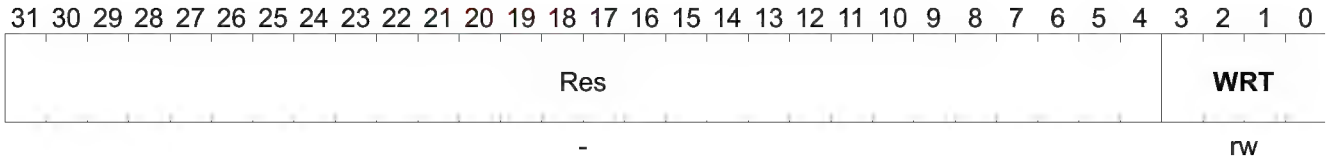
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res																												DACT			
-																												rw			

Field	Bits	Type	Description
Res	31:4	-	**Reserved** Read undefined. Must be written as zeros.
DACT	3:0	rw	**Data-In to Active Command Time** 0_H 1 clock cycle ...H F_H 16 clock cycles (reset value on nPOR)

MPMC Dynamic WR

Note: The delay is in MPMCCLK cycles.

MPMC_DWR	Offset	Reset Value
MPMC Dynamic WR	044_H	F_H

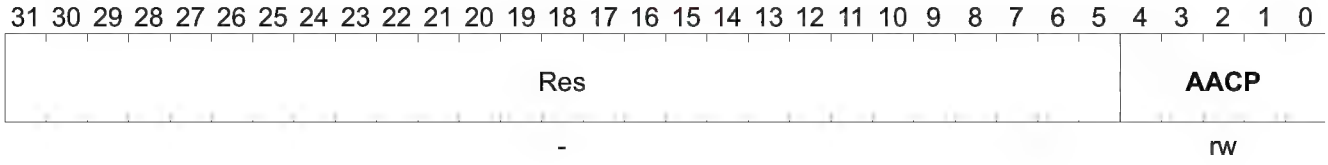


Field	Bits	Type	Description
Res	31:4	-	**Reserved**
WRT	3:0	rw	**Write Recovery Time** 0_H 1 clock cycle ...H F_H 16 clock cycles (reset value on nPOR)

MPMC Dynamic RC

Note: The delay is in MPMCCLK cycles.

MPMC_DRC	Offset	Reset Value
MPMC Dynamic RC	048_H	$1F_H$

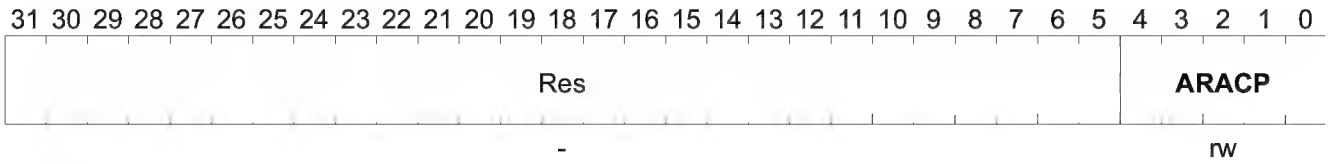


Field	Bits	Type	Description
Res	31:5	-	**Reserved**
AACP	4:0	rw	**Active to Active Command Period** 0_H 1 clock cycle ...H $1F_H$ 32 clock cycles (reset value on nPOR)

MPMC Dynamic RFC

Note: The delay is in MPMCCLK cycles.

MPMC_DRFC	Offset	Reset Value
MPMC Dynamic RFC	$04C_H$	$1F_H$

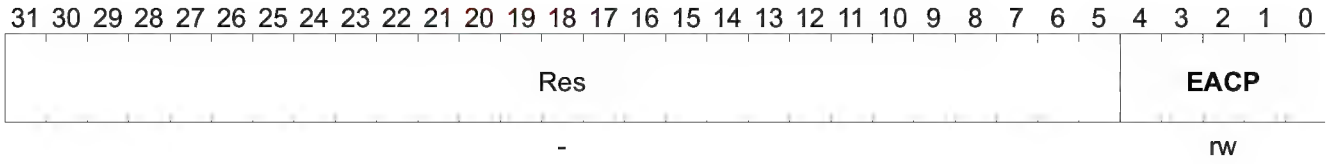


Field	Bits	Type	Description
Res	31:5	-	**Reserved**
ARACP	4:0	rw	**Auto Refresh Period and Auto Refresh to Active Command Period** 0_H 1 clock cycle ...H $1F_H$ 32 clock cycles (reset value on nPOR)

MPMC Dynamic XSR

Note: The delay is in MPMCCLK cycles.

MPMC_DXSR	Offset	Reset Value
MPMC Dynamic XSR	050_H	$1F_H$

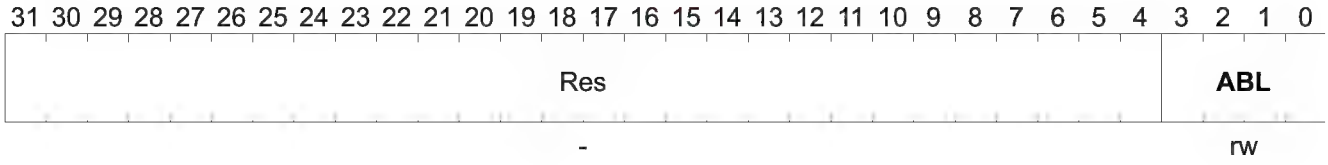


Field	Bits	Type	Description
Res	31:5	-	**Reserved**
EACP	4:0	rw	**Exit Self-Refresh to Active Command Period** 0_H 1 clock cycle ...H $1F_H$ 32 clock cycles (reset value on nPOR)

MPMC Dynamic RRD

Note: The delay is in MPMCCLK cycles.

MPMC_DRRD	Offset	Reset Value
MPMC Dynamic RRD	054_H	F_H

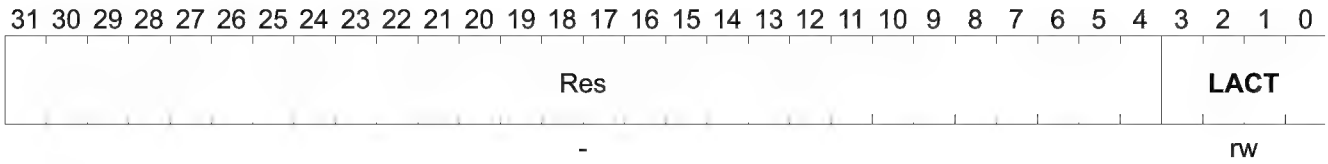


Field	Bits	Type	Description
Res	31:4	-	**Reserved**
ABL	3:0	rw	**Active Bank A to Active Bank B Latency** 0_H 1 clock cycle ...H F_H 16 clock cycles (reset value on nPOR)

MPMC Dynamic MRD

Note: The delay is in MPMCCLK cycles.

MPMC_DMRD	Offset	Reset Value
MPMC Dynamic MRD	058_H	F_H

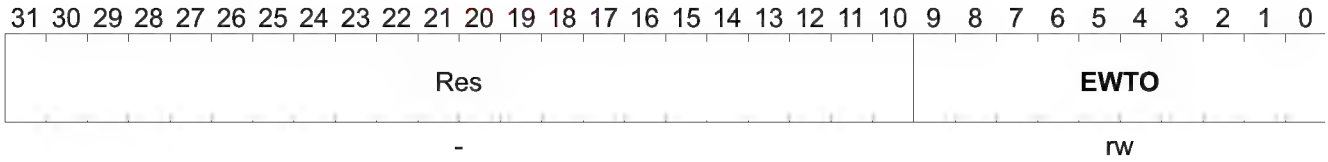


Field	Bits	Type	Description
Res	31:4	-	**Reserved**
LACT	3:0	rw	**Load Mode Register to Active Command Time** 0_H 1 clock cycle ...H F_H 16 clock cycles (reset value on nPOR)

MPMC Static Extended Wait

Note: The delay is in HCLK cycles.

MPMC_SEW	Offset	Reset Value
MPMC Static Extended Wait	080_H	0_H



Field	Bits	Type	Description
Res	31:10	-	**Reserved**
EWTO	9:0	rw	**External Wait Time Out** 0_D 16 clock cycles (reset value on nPOR) $\cdots_D$ n_D (n+1) x16 clock cycles *Note: n = 0 to $3FF_H$*

MPMC Dynamic Config 0

Note: The offset 100_H and 120_H is for SDRAM bank0 and bank1 respectively.

MPMC_DC0	Offset	Reset Value
MPMC Dynamic Config 0	100_H	0_H

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Res		RW		Res	NB	Res		CW		Res	WP	BE	Res		
-		rw		-	rw	-		rw		-	rw	rw	-		

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res	AM_1	Res		AM_2					Res		MD		Res		
-	rw	-		rw					-		rw		-		

Field	Bits	Type	Description
Res	31:30	-	**Reserved**
RW	29:28	rw	**Row Width** 00_B 11-bit (reset value on nPOR) 01_B 12-bit 10_B 13-bit 11_B Reserved
Res	27	-	**Reserved**
NB	26	rw	**Number of Banks** 0_B Two banks (reset value on nPOR) 1_B Four banks
Res	25	-	**Reserved**
CW	24:22	rw	**Column Width** 000_B 6-bit (reset value on nPOR) 001_B 7-bit 010_B 8-bit 011_B 9-bit 100_B 10-bit 101_B 11-bit 110_B Reserved 111_B Reserved
Res	21	-	**Reserved**
WP	20	rw	**Write Protect** 0_B Writes not protected (reset value on nPOR) 1_B Write protected.
BE	19	rw	**Buffer Enable** 0_B Buffer disabled for accesses to this chip select (reset value on nPOR) 1_B Buffer enabled for accesses to this chip select.

Field	Bits	Type	Description
Res	18:15	-	**Reserved**
AM_1	14	rw	**Address Mapping** See **Table 30** 0_B Reset value on nPOR
Res	13	-	**Reserved**
AM_2	12:7	rw	**Address Mapping** See , **Table 30** 00000000_B Reset value on nPOR
Res	6:5	-	**Reserved**
MD	4:3	rw	**Memory Device** 00_B SDRAM(reset value on nPOR) 01_B Low-power SDRAM 10_B Reserved 11_B Reserved
Res	2:0	-	**Reserved**

Table 30 Address Mapping Table

[14]	[12]	[11:9]	[8:7]	Description
16-Bit external bus high performance address mapping (Row, Bank, Column)				
0	0	000	00	16MB (2M X 8),2 banks row length=11, column length=9
0	0	000	01	16MB (1M X 16),2 banks, row length=11, column length=8
0	0	001	00	64MB (8M X 8),4 banks, row length=12, column length=9
0	0	001	01	64MB (4M X16),4 banks, row length=12, column length=8
0	0	010	00	128MB (16M X 8),4 banks, row length=12, column length=10
0	0	010	01	128MB (8M X 16), 4 banks, row length=12, column length=9
0	0	011	00	256MB (32M X 8), 4 banks, row length=13, column length=10
0	0	011	01	256MB (16M X 16), 4 banks, row length=13, column length=9
0	0	100	00	512MB (64M X 8), 4 banks, row length=13, column length=11
0	0	100	00	512MB (32M X 16),4 banks, row length=13, column length=10
16-Bit external bus Low-power SDRAM address mapping (Bank, row, Column)				
0	1	000	00	16MB (2M X 8),2 banks row length=11, column length=9
0	1	000	01	16MB (1M X 16),2 banks, row length=11, column length=8
0	1	001	00	64MB (8M X 8),4 banks, row length=12, column length=9
0	1	001	01	64MB (4M X16),4 banks, row length=12, column length=8
0	1	010	00	128MB (16M X 8),4 banks, row length=12, column length=10

Table 30 Address Mapping Table

[14]	[12]	[11:9]	[8:7]	Description
0	1	010	01	128MB (8M X 16), 4 banks, row length=12, column length=9
0	1	011	00	256MB (32M X 8), 4 banks, row length=13, column length=10
0	1	011	01	256MB (16M X 16), 4 banks, row length=13, column length=9
0	1	100	00	512MB (64M X 8), 4 banks, row length=13, column length=11
0	1	100	01	512MB (32M X 16), 4 banks, row length=13, column length=10
32-Bit external bus High-Performance address mapping (Row, Bank, Column)				
1	0	000	00	16MB (2M X 8), 2 banks, row length=11, column length=9
1	0	000	01	16MB (1M X 16), 2 banks, row length=11, column length=8
1	0	001	00	64MB (8M X 8), 4 banks, row length=12, column length=9
1	0	001	01	64MB (4M X 16), 4 banks, row length=12, column length=8
1	0	001	10	64MB (2M X 32), 4 banks, row length=11, column length=8
1	0	010	00	128MB (16M X 8),4 banks, row length=12, column length=10
1	0	010	01	128MB (8M X 16), 4 banks, row length=12, column length=9
1	0	010	10	128MB (4M X 32), 4 banks, row length=12, column length=8
1	0	011	00	256MB (32M X 8), 4 banks, row length=13, column length=10
1	0	011	01	256MB (16M X 16), 4 banks, row length13, column length=9
1	0	011	10	256MB (8M X 32), 4 banks, row length=13, column length=8
1	0	100	00	512MB (64M X8),4 banks, row length=13, column length=11
1	0	100	01	512MB (32M X 16),4 banks, row length=13, column length=10
32-Bit external bus Low-Performance SDRAM mapping (Bank,Row, Column)				
1	0	100	01	512MB (32M X 16),4 banks, row length=13, column length=10
1	1	000	00	16MB (2M X 8), 2 banks, row length=11, column length=9
1	1	000	01	16MB (1M X 16), 2 banks, row length=11, column length=8
1	1	001	00	64MB (8M X 8), 4 banks, row length=12, column length=9
1	1	001	01	64MB (4M X 16), 4 banks, row length=12, column length=8
1	1	001	10	64MB (2M X 32), 4 banks, row length=11, column length=8
1	1	010	00	128MB (16M X 8),4 banks, row length=12, column length=10
1	1	010	01	128MB (8M X 16), 4 banks, row length=12, column length=9
1	1	010	10	128MB (4M X 32), 4 banks, row length=12, column length=8
1	1	011	00	256MB (32M X 8), 4 banks, row length=13, column length=10
1	1	011	01	256MB (16M X 16), 4 banks, row length13, column length=9
1	1	011	10	256MB (8M X 32), 4 banks, row length=13, column length=8
1	1	100	00	512MB (64M X8),4 banks, row length=13, column length=11
1	1	100	01	512MB (32M X 16),4 banks, row length=13, column length=10

MPMC Dynamic Config 1

Note: The offset 100_H and 120_H is for SDRAM bank0 and bank1 respectively.

MPMC_DC1	Offset	Reset Value
MPMC Dynamic Config 1	120_H	0_H

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Res		RW		Res	NB	Res		CW		Res	WP	BE	Res		
-		rw		-	rw	-		rw		-	rw	rw	-		

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res	AM_1	Res		AM_2					Res		MD		Res		
-	rw	-		rw					-		rw		-		

Field	Bits	Type	Description
Res	31:30	-	**Reserved**
RW	29:28	rw	**Row Width** 00_B 11-bit (reset value on nPOR) 01_B 12-bit 10_B 13-bit 11_B Reserved
Res	27	-	**Reserved**
NB	26	rw	**Number of Banks** 0_B Two banks (reset value on nPOR) 1_B Four banks
Res	25	-	**Reserved**
CW	24:22	rw	**Column Width** 000_B 6-bit (reset value on nPOR) 001_B 7-bit 010_B 8-bit 011_B 9-bit 100_B 10-bit 101_B 11-bit 110_B Reserved 111_B Reserved
Res	21	-	**Reserved**
WP	20	rw	**Write Protect** 0_B Writes not protected (reset value on nPOR) 1_B Write protected.
BE	19	rw	**Buffer Enable** 0_B Buffer disabled for accesses to this chip select (reset value on nPOR) 1_B Buffer enabled for accesses to this chip select.

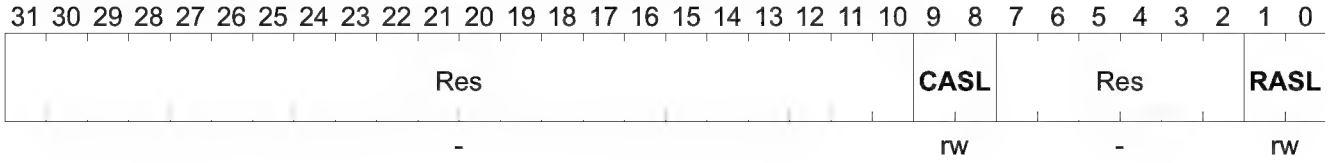
Field	Bits	Type	Description
Res	18:15	-	**Reserved**
AM_1	14	rw	**Address Mapping** See **Table 30** 0_B Reset value on nPOR
Res	13	-	**Reserved**
AM_2	12:7	rw	**Address Mapping** See , **Table 30** 00000000_B Reset value on nPOR
Res	6:5	-	**Reserved**
MD	4:3	rw	**Memory Device** 00_B SDRAM(reset value on nPOR) 01_B Low-power SDRAM 10_B Reserved 11_B Reserved
Res	2:0	-	**Reserved**

MPMC Dynamic Ras Cas 0

Notes

1. *The RAS to CAS latency (RAS) and CAS latency (CAS) are both defined in MPMCCLK cycles.*
2. *The offset 104_H and 124_H is for SDRAM bank0 and bank1 respectively.*

MPMC_DRC0	Offset	Reset Value
MPMC Dynamic Ras Cas 0	**104_H**	**303_H**



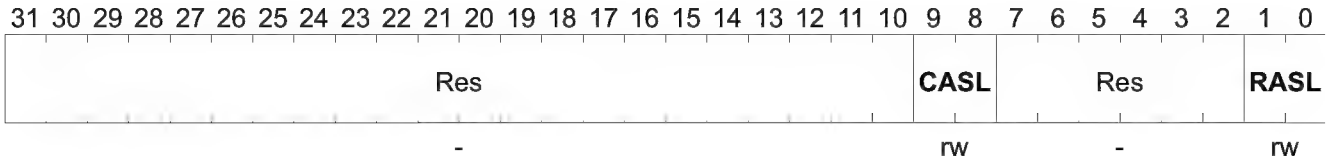
Field	Bits	Type	Description
Res	31:10	-	**Reserved**
CASL	9:8	rw	**CAS Latency** 00_B Reserved 01_B One clock cycle(a) 10_B Two clock cycles 11_B Three clock cycles(reset value on nPOR).
Res	7:2	-	**Reserved**
RASL	1:0	rw	**RAS Latency** Active to read or write delay 00_B Reserved 01_B One clock cycle(a) 10_B Two clock cycles 11_B Three clock cycles (reset value on nPOR).

MPMC Dynamic Ras Cas 1

Notes

1. *The RAS to CAS latency (RAS) and CAS latency (CAS) are both defined in MPMCCLK cycles.*
2. *The offset 104_H and 124_H is for SDRAM bank0 and bank1 respectively.*

MPMC_DRC1	Offset	Reset Value
MPMC Dynamic Ras Cas 1	124_H	303_H



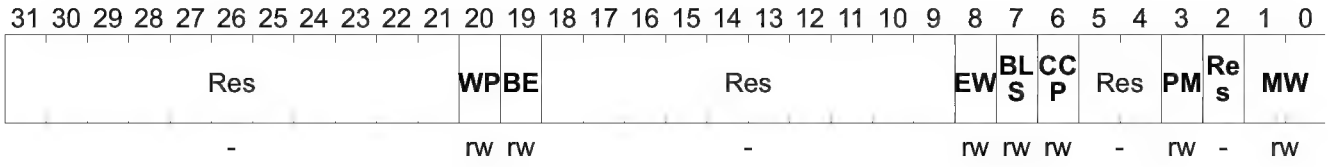
Field	Bits	Type	Description
Res	31:10	-	**Reserved**
CASL	9:8	rw	**CAS Latency** 00_B Reserved 01_B One clock cycle(a) 10_B Two clock cycles 11_B Three clock cycles(reset value on nPOR).
Res	7:2	-	**Reserved**
RASL	1:0	rw	**RAS Latency** Active to read or write delay 00_B Reserved 01_B One clock cycle(a) 10_B Two clock cycles 11_B Three clock cycles (reset value on nPOR).

MPMC Static Config 1

Notes

1. *Offset = 220_H is for F_CS0_N respectively.*
2. *Offset = 240_H, is for External IO CSX0.*
3. *Offset =260_H is for External IO CSX1.*
4. *Synchronous burst mode memory devices are not supported.*

MPMC_SC1	Offset	Reset Value
MPMC Static Config 1	220_H	0_H



Field	Bits	Type	Description
Res	31:21	-	**Reserved**
WP	20	rw	**Write Protect** 0_B Writes not protected (reset value on nPOR) 1_B Write protected
BE	19		**Buffer Enable** 0_B Write buffer disabled (reset value on nPOR) 1_B Write buffer enabled
Res	18:9	-	**Reserved**
EW	8	rw	**Extended Wait** 0_B Extended wait disabled (reset value on nPOR) 1_B Extended wait enabled
BLS	7		**Byte Lane State** 0_B For reads all the bits in nMPMCBLSOUT[3:0] are HIGH(reset value on nPOR).For writes the respective active bits innMPMCBLSOUT[3:0] are LOW. 1_B For reads the respective active bits in nMPMCBLSOUT[3:0] are LOW. For writes the respective active bits in nMPMCBLSOUT[3:0] are LOW.
CCP	6	rw	**Chip Select Polarity** The values of the chip select polarity on power-on-reset(nPOR) is determined by the relevant MPMCSxPOL signal. This value can be overridden by software. This field is Unaffected by AHB reset (HRESETn). 0_B Active LOW chip select 1_B Active HIGH chip select
Res	5:4	-	**Reserved**

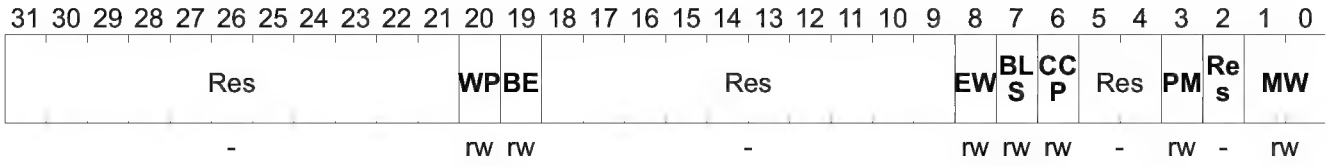
Field	Bits	Type	Description
PM	3	rw	**Page Mode** 0_B Disabled (reset value on nPOR) 1_B Async page mode four enabled.
Res	2	-	**Reserved**
MW	1:0	rw	**Memory Width Define** The memory width field define the data width of F_CS0_N. And the default value will be the reset latched value on pins A[18:17]. 00_B 8 bit 01_B 16 bit 10_B 32 bit 11_B Reserved.

MPMC Static Config 2

Notes

1. *Offset = 220_H is for F_CS0_N respectively.*
2. *Offset = 240_H, is for External IO CSX0.*
3. *Offset =260_H is for External IO CSX1.*
4. *Synchronous burst mode memory devices are not supported.*

MPMC_SC2	Offset	Reset Value
MPMC Static Config 2	240_H	0_H



Field	Bits	Type	Description
Res	31:21	-	**Reserved**
WP	20	rw	**Write Protect** 0_B Writes not protected (reset value on nPOR) 1_B Write protected
BE	19		**Buffer Enable** 0_B Write buffer disabled (reset value on nPOR) 1_B Write buffer enabled
Res	18:9	-	**Reserved**
EW	8	rw	**Extended Wait** 0_B Extended wait disabled (reset value on nPOR) 1_B Extended wait enabled
BLS	7		**Byte Lane State** 0_B For reads all the bits in nMPMCBLSOUT[3:0] are HIGH(reset value on nPOR).For writes the respective active bits innMPMCBLSOUT[3:0] are LOW. 1_B For reads the respective active bits in nMPMCBLSOUT[3:0] are LOW. For writes the respective active bits in nMPMCBLSOUT[3:0] are LOW.
CCP	6	rw	**Chip Select Polarity** The values of the chip select polarity on power-on-reset(nPOR) is determined by the relevant MPMCSxPOL signal. This value can be overridden by software. This field is Unaffected by AHB reset (HRESETn). 0_B Active LOW chip select 1_B Active HIGH chip select
Res	5:4	-	**Reserved**

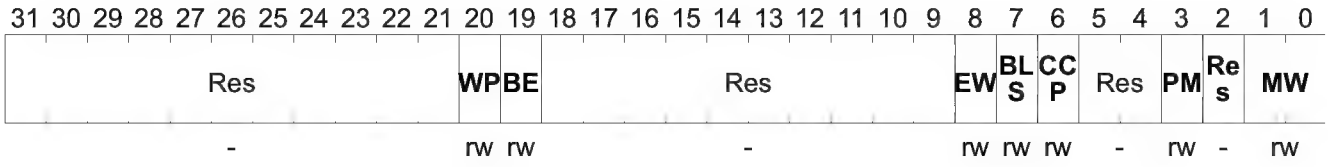
Field	Bits	Type	Description
PM	3	rw	**Page Mode** 0_B Disabled (reset value on nPOR) 1_B Async page mode four enabled.
Res	2	-	**Reserved**
MW	1:0	rw	**Memory Width Define** The memory width field defines the data width of External IO CSX0. 00_B 8 bit 01_B 16 bit 10_B 32 bit 11_B Reserved.

MPMC Static Config 3

Notes

1. *Offset = 220_H is for F_CS0_N respectively.*
2. *Offset = 240_H, is for External IO CSX0.*
3. *Offset =260_H is for External IO CSX1.*
4. *Synchronous burst mode memory devices are not supported.*

MPMC_SC3	Offset	Reset Value
MPMC Static Config 3	260_H	0_H



Field	Bits	Type	Description
Res	31:21	-	**Reserved**
WP	20	rw	**Write Protect** 0_B Writes not protected (reset value on nPOR) 1_B Write protected
BE	19		**Buffer Enable** 0_B Write buffer disabled (reset value on nPOR) 1_B Write buffer enabled
Res	18:9	-	**Reserved**
EW	8	rw	**Extended Wait** 0_B Extended wait disabled (reset value on nPOR) 1_B Extended wait enabled
BLS	7		**Byte Lane State** 0_B For reads all the bits in nMPMCBLSOUT[3:0] are HIGH(reset value on nPOR).For writes the respective active bits innMPMCBLSOUT[3:0] are LOW. 1_B For reads the respective active bits in nMPMCBLSOUT[3:0] are LOW. For writes the respective active bits in nMPMCBLSOUT[3:0] are LOW.
CCP	6	rw	**Chip Select Polarity** The values of the chip select polarity on power-on-reset(nPOR) is determined by the relevant MPMCSxPOL signal. This value can be overridden by software. This field is Unaffected by AHB reset (HRESETn). 0_B Active LOW chip select 1_B Active HIGH chip select
Res	5:4	-	**Reserved**

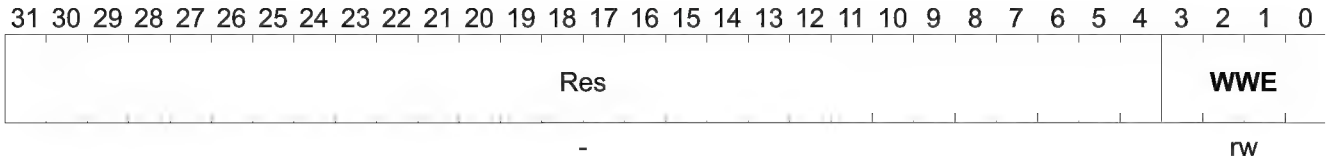
Field	Bits	Type	Description
PM	3	rw	**Page Mode** 0_B Disabled (reset value on nPOR) 1_B Async page mode four enabled.
Res	2	-	**Reserved**
MW	1:0	rw	**Memory Width** The memory width field defines the data width of External IO CSX1. 00_B 8 bit 01_B 16 bit 10_B 32 bit 11_B Reserved.

MPMC Static Wait Wen 1

Notes

1. *Offset = 224_H is for F_CS0_N .*
2. *The delay is (WAITWEN+1) x tHCLK.*

MPMC_SWW1	Offset	Reset Value
MPMC Static Wait Wen 1	**224_H**	**0_H**



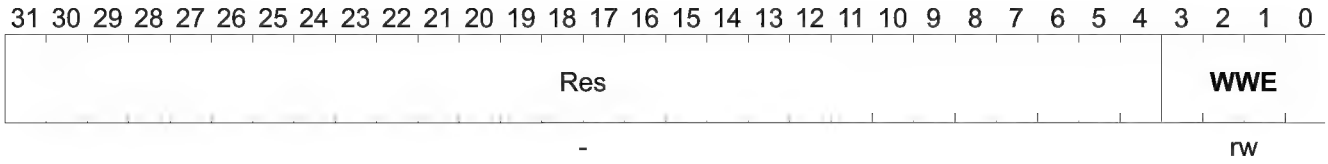
Field	Bits	Type	Description
Res	31:4	-	**Reserved**
WWE	3:0	rw	**Wait Write Enable** Delay from chip select assertion to write enable. 0000_B One HCLK cycle delay between assertion of chip select and write enable (reset value on nPOR) 0001 to 1111_B =(n+1) HCLK cycle delay.

MPMC Static Wait Wen 2

Notes

1. *Offset = 244_H refers to External IO CSX0.*
2. *The delay is (WAITWEN+1) x tHCLK.*

MPMC_SWW2	Offset	Reset Value
MPMC Static Wait Wen 2	**244_H**	**0_H**



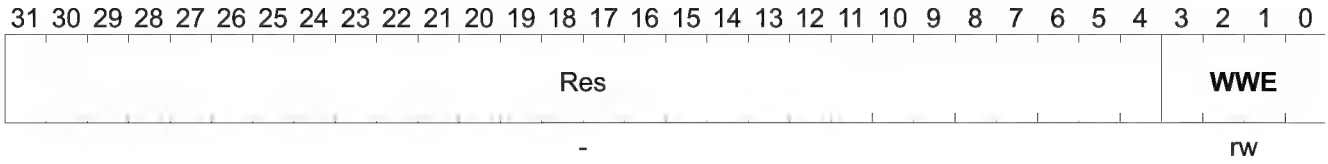
Field	Bits	Type	Description
Res	31:4	-	**Reserved**
WWE	3:0	rw	**Wait Write Enable** Delay from chip select assertion to write enable. 0000_B One HCLK cycle delay between assertion of chip select and write enable (reset value on nPOR) 0001 to 1111_B =(n+1) HCLK cycle delay.

MPMC Static Wait Wen 3

Notes

1. *Offset = 264_H refers to External IO CSX1.*
2. *The delay is (WAITWEN+1) x tHCLK.*

MPMC_SWW3	Offset	Reset Value
MPMC Static Wait Wen 3	**264_H**	**0_H**



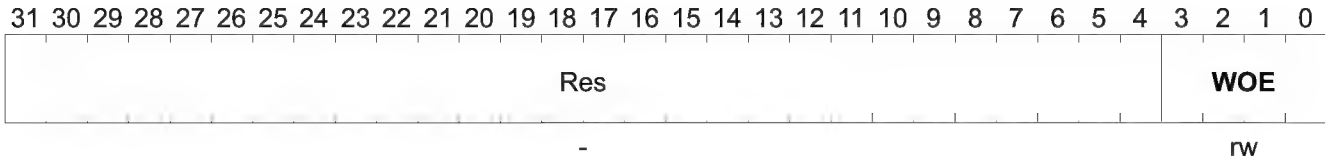
Field	Bits	Type	Description
Res	31:4	-	**Reserved**
WWE	3:0	rw	**Wait Write Enable** Delay from chip select assertion to write enable. 0000_B One HCLK cycle delay between assertion of chip select and write enable (reset value on nPOR) 0001 to 1111_B =(n+1) HCLK cycle delay.

MPMC Static Wait Oen 1

Notes

1. *Offset = 228_H is for F_CS0_N .*
2. *The delay is WAITOEN x tHCLK.*

MPMC_SWO1	Offset	Reset Value
MPMC Static Wait Oen 1	228_H	0_H



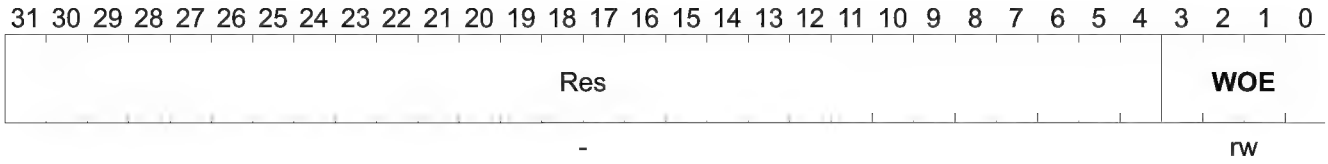
Field	Bits	Type	Description
Res	31:4	-	**Reserved**
WOE	3:0	rw	**Wait Output Enable** Delay from chip select assertion to output enable. 0000_B No delay (reset value on nPOR) 0001 to 1111_B n cycle delay

MPMC Static Wait Oen 2

Notes

1. *Offset = 248_H refers to EXTERNAL IO CSX0.*
2. *The delay is WAITOEN x tHCLK.*

MPMC_SWO2	Offset	Reset Value
MPMC Static Wait Oen 2	**248_H**	**0_H**



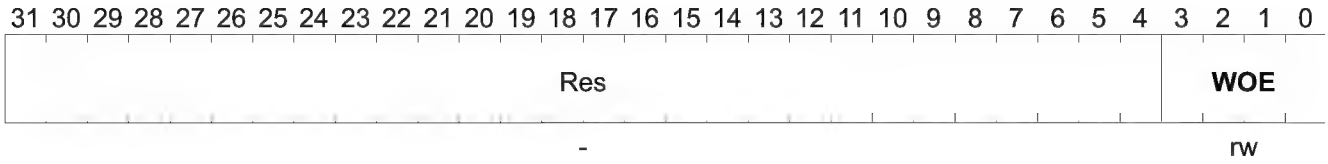
Field	Bits	Type	Description
Res	31:4	-	**Reserved**
WOE	3:0	rw	**Wait Output Enable** Delay from chip select assertion to output enable. 0000_B No delay (reset value on nPOR) 0001 to 1111_B n cycle delay

MPMC Static Wait Oen 3

Notes

1. *Offset = 268_H refers to External IO CSX1.*
2. *The delay is WAITOEN x tHCLK.*

MPMC_SWO3	Offset	Reset Value
MPMC Static Wait Oen 3	**268_H**	**0_H**



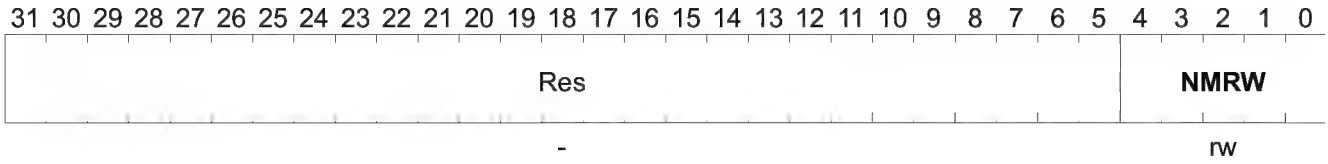
Field	Bits	Type	Description
Res	31:4	-	**Reserved**
WOE	3:0	rw	**Wait Output Enable** Delay from chip select assertion to output enable. 0000_B No delay (reset value on nPOR) 0001 to 1111_B n cycle delay

MPMC Static Wait Rd 1

Notes

1. *Offset = $22C_H$ is for F_CS0_N .*
2. *For non-sequential reads, the wait state time is (WAITRD+1) x tHCLK.*

MPMC_SWR1	Offset	Reset Value
MPMC Static Wait Rd 1	$22C_H$	$1F_H$

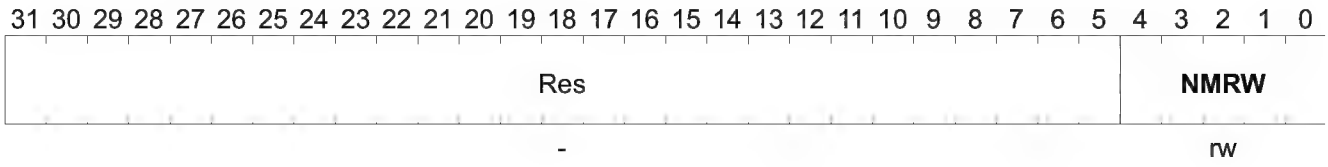


Field	Bits	Type	Description
Res	31:5	-	**Reserved**
NMRW	4:0	rw	**Nonpage Mode Read Wait** Nonpage mode read wait states or asynchronous page mode read first access wait state. **Nonpage Mode** 00000 to 11110_B (n+1) HCLK cycles for read accesses 11111_B 32 HCLK cycles for read accesses(reset value on nPOR). **Asynchronous Page Mode Read, First Read Only** 00000 to 11110_B (n+1) HCLK cycles for burst read accesses 11111_B 32 HCLK cycles for page read accesses (reset value on nPOR)

MPMC Static Wait Rd 2

Note: Offset = $24C_H$ refers to External IO CSX0.

MPMC_SWR2	Offset	Reset Value
MPMC Static Wait Rd 2	$24C_H$	$1F_H$

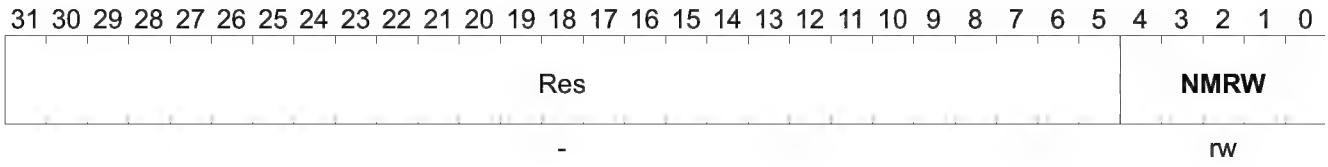


Field	Bits	Type	Description
Res	31:5	-	**Reserved**
NMRW	4:0	rw	**Nonpage Mode Read Wait** Nonpage mode read wait states or asynchronous page mode read first access wait state. **Nonpage Mode** 00000 to 11110_B (n+1) HCLK cycles for read accesses 11111_B 32 HCLK cycles for read accesses(reset value on nPOR). **Asynchronous Page Mode Read, First Read Only** 00000 to 11110_B (n+1) HCLK cycles for burst read accesses 11111_B 32 HCLK cycles for page read accesses (reset value on nPOR)

MPMC Static Wait Rd 3

Note: Offset = $26C_H$ refers to External CSX1.

MPMC_SWR3	Offset	Reset Value
MPMC Static Wait Rd 3	$26C_H$	$1F_H$



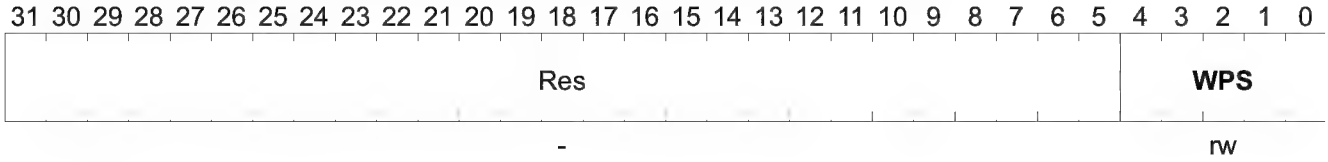
Field	Bits	Type	Description
Res	31:5	-	**Reserved**
NMRW	4:0	rw	**Nonpage Mode Read Wait** Nonpage mode read wait states or asynchronous page mode read first access wait state. **Nonpage Mode** 00000 to 11110_B (n+1) HCLK cycles for read accesses 11111_B 32 HCLK cycles for read accesses(reset value on nPOR). **Asynchronous Page Mode Read, First Read Only** 00000 to 11110_B (n+1) HCLK cycles for burst read accesses 11111_B 32 HCLK cycles for page read accesses (reset value on nPOR)

MPMC Static Wait Page 1

Notes

1. *Offset = 230_H is for F_CS0_N .*
2. *For asynchronous page mode read for sequential read, the wait state time for page mode accesses after the first read is (WAITPAGE+1) x tHCLK.*

MPMC_SWP1	Offset	Reset Value
MPMC Static Wait Page 1	230_H	$1F_H$

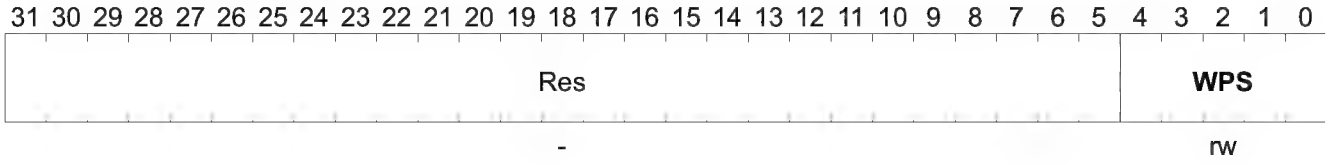


Field	Bits	Type	Description
Res	31:5	-	**Reserved**
WPS	4:0	rw	**Asynchronous Page Mode Read After the First Access Wait States** Number of wait states for asynchronous page mode read accesses after the first read. 00000 to 11110_B (n+1) HCLK cycle read access time 11111_B 32 HCLK cycle read access time (reset value on nPOR).

MPMC Static Wait Page 2

Note: Offset = 250_H refers to External CSX0.

MPMC_SWP2	Offset	Reset Value
MPMC Static Wait Page 2	250_H	$1F_H$

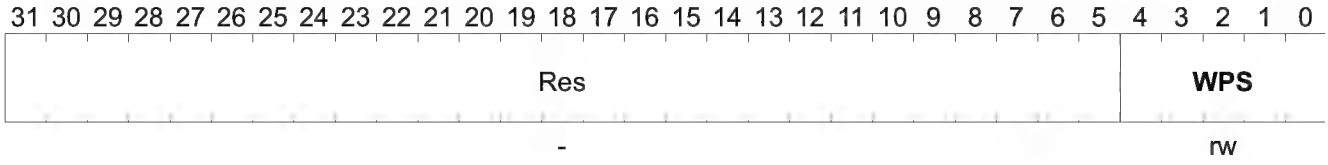


Field	Bits	Type	Description
Res	31:5	-	**Reserved**
WPS	4:0	rw	**Asynchronous Page Mode Read After the First Access Wait States** Number of wait states for asynchronous page mode read accesses after the first read. 00000 to 11110_B (n+1) HCLK cycle read access time 11111_B 32 HCLK cycle read access time (reset value on nPOR).

MPMC Static Wait Page 3

Note: Offset = 270_H refers to External CSX1.

MPMC_SWP3	Offset	Reset Value
MPMC Static Wait Page 3	270_H	$1F_H$



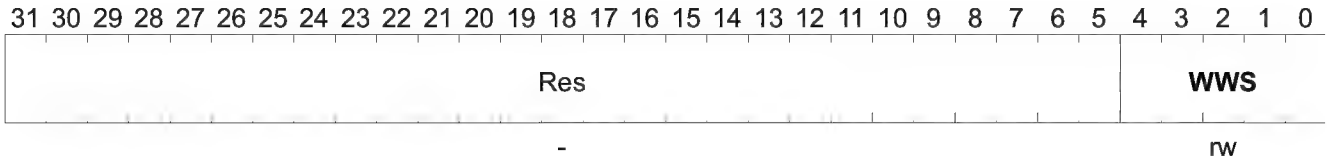
Field	Bits	Type	Description
Res	31:5	-	**Reserved**
WPS	4:0	rw	**Asynchronous Page Mode Read After the First Access Wait States** Number of wait states for asynchronous page mode read accesses after the first read. 00000 to 11110_B (n+1) HCLK cycle read access time 11111_B 32 HCLK cycle read access time (reset value on nPOR).

MPMC Static Wait Wr 1

Notes

1. *Offset = 234_H is for F_CS0_N .*
2. *The wait state time for write accesses after the first read is WAITWR x tHCLK.*

MPMC_SWWR1	Offset	Reset Value
MPMC Static Wait Wr 1	234_H	$1F_H$

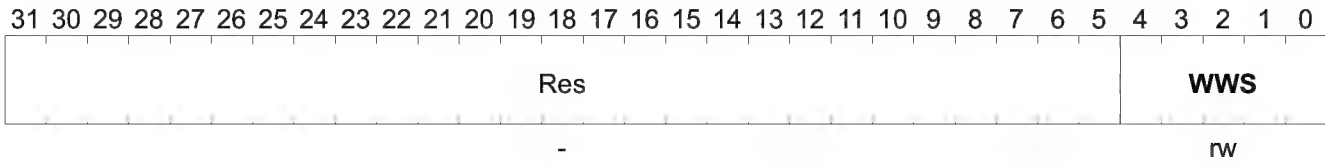


Field	Bits	Type	Description
Res	31:5	-	**Reserved**
WWS	4:0	rw	**Write Wait States** SRAM wait state time for write accesses after the first read. 00000 to 11110_B (n+2) HCLK cycle write access time 11111_B 33 HCLK cycle write access time (reset value on nPOR).

MPMC Static Wait Wr 2

Note: Offset = 254_H refers to external CSX0.

MPMC_SWWR2	Offset	Reset Value
MPMC Static Wait Wr 2	254_H	$1F_H$

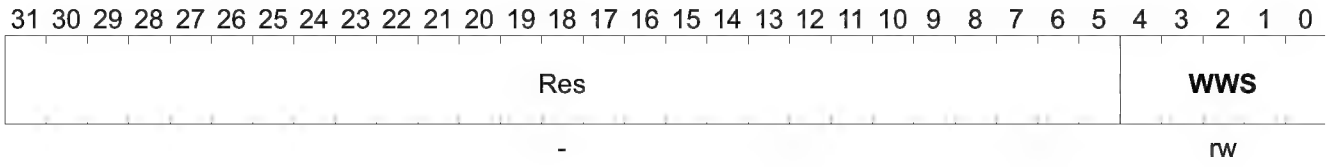


Field	Bits	Type	Description
Res	31:5	-	**Reserved**
WWS	4:0	rw	**Write Wait States** SRAM wait state time for write accesses after the first read. 00000 to 11110_B (n+2) HCLK cycle write access time 11111_B 33 HCLK cycle write access time (reset value on nPOR).

MPMC Static Wait Wr 3

Note: Offset = 274_H refers to External CSX1.

MPMC_SWWR3	Offset	Reset Value
MPMC Static Wait Wr 3	274_H	$1F_H$



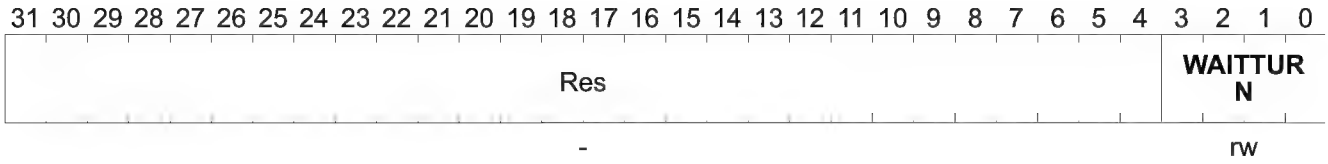
Field	Bits	Type	Description
Res	31:5	-	**Reserved**
WWS	4:0	rw	**Write Wait States** SRAM wait state time for write accesses after the first read. 00000 to 11110_B (n+2) HCLK cycle write access time 11111_B 33 HCLK cycle write access time (reset value on nPOR).

MPMC Static Wait Turn 1

Notes

1. *Offset = 238_H is for F_CS0_N .*
2. *Bus turnaround time is (WAITTURN+1) x tHCLK.*

MPMC_SWT1	Offset	Reset Value
MPMC Static Wait Turn 1	238_H	F_H

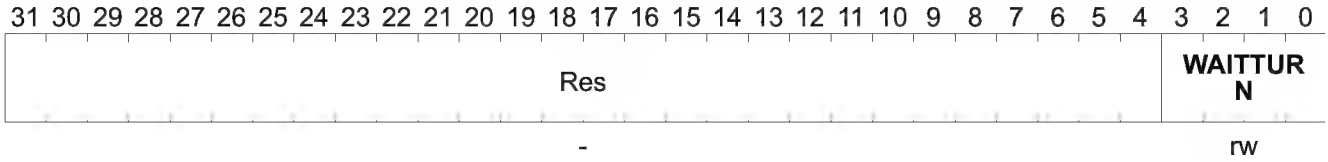


Field	Bits	Type	Description
Res	31:4	-	**Reserved**
WAITTURN	3:0	rw	**Bus Turnaround Cycles** 00000 to 1110_B (n+1) HCLK turnaround cycles 1111_B 16 HCLK turnaround cycles (reset value on nPOR).

MPMC Static Wait Turn 2

Note: Offset = 258_H refers to External CSX0.

MPMC_SWT2	Offset	Reset Value
MPMC Static Wait Turn 2	258_H	F_H

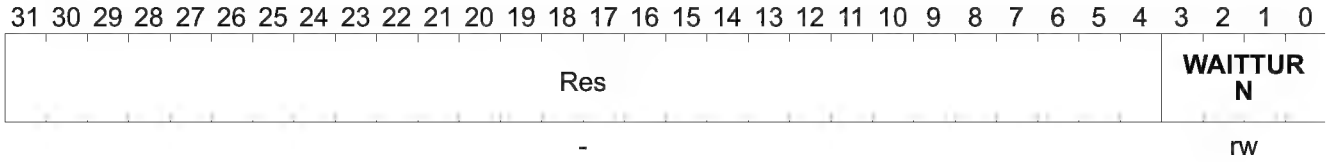


Field	Bits	Type	Description
Res	31:4	-	**Reserved**
WAITTURN	3:0	rw	**Bus Turnaround Cycles** 00000 to 1110_B (n+1) HCLK turnaround cycles 1111_B 16 HCLK turnaround cycles (reset value on nPOR).

MPMC Static Wait Turn 3

Note: Offset = 278_H refers to External CSX1.

MPMC_SWT3	Offset	Reset Value
MPMC Static Wait Turn 3	278_H	F_H



Field	Bits	Type	Description
Res	31:4	-	**Reserved**
WAITTURN	3:0	rw	**Bus Turnaround Cycles** 00000 to 1110_B (n+1) HCLK turnaround cycles 1111_B 16 HCLK turnaround cycles (reset value on nPOR).

6 Ethernet Switch Controller

The following chapter describes the Ethernet Switch controller functions of the ADM5120P/PX.

6.1 Switch Engine

The switch engine description:

6.1.1 Hashing Function

ADM5120P/PX provides an embedded 1K MAC address look-up table to implement address recognition. The entries of the hashing table are calculated by direct mapping or by an XOR function to produce a 10-bit hashing address entry.

6.1.2 Learning Process

The address learning process is composed of the source address (SA) of packets and the hashing function. ADM5120P/PX will compare the SA of each incoming packet:

- If the source address of an incoming packet is the same as the source MAC address table, then the aging status and port number will be updated.
- If the source address is different from the source MAC address table (mean address collision), then no learning process will occur.

Exceptional cases of address learning:

- The packets have errors
- The port learning has been disabled
- Address collision
- The source address is multicast
- The packets are from the CPU

6.1.3 Routing

When a packet comes from port A, ADM5120P/PX will compare its destination MAC address with the MAC address in the MAC address lookup table. If the address is the same and port is port A this means that the packet is a local packet, it is thus discarded. If the address is the same but port numbers are different, the packet is a unicast packet, and will be forwarded to the assigned port. If the incoming packet is a broadcasted one, a multicast one, or an unknown one (i.e. the destination address cannot be found in the MAC address lookup table), then the routing scheme will broadcast it to all ports.

If the MAC address is a VLAN address, then the packet will be routed to the CPU port. The VLAN address is programmed by the CPU, but not from address learning.

6.1.4 Forwarding

ADM5120P/PX provides a store-and-forward method as a forwarding scheme. Each outgoing packet, including “to-CPU” packets, will be stored,first in the buffer, and then directly sent to the assigned port or CPU via the DMA. However, only the good and non-local packets will be sent.

6.1.5 Buffer Management

The buffer memory is embedded in ADM5120P/PX for the switch operations, which are designed based on output queuing and dynamic shared memory management architecture. It will assign buffer resources based on the traffic status. In addition, this efficiency method can avoid the problem of Head-on-Line (HOL) blocking and cause better transmitting performance.

6.1.6 Flow Control

The on/off status for flow control depends on the global empty buffer count and per-port waiting-transmit count. Based on this intelligent scheme, if the packet transmits to a destination port that is full, then the flow control is turned on. In this situation, the full condition is released, including packets transmitted out or disabled. The flow control is then turned off.

ADM5120P/PX does not allow flow control to the CPU, i.e.. it never sends the flow control packets to the CPU port, so the firmware needs to monitor the buffer status to prevent packet loss.

6.1.7 Full Duplex

In full duplex flow control, ADM5120P/PX follows IEEE 802.3x standards. If a PAUSE frame is received from a certain port, it will stop the port transmission of packets until the timer times out or another PAUSE frame with zero time is received. If the buffer is full and is in full-duplex mode, ADM5120P/PX will send a PAUSE frame with the maximum value, to defer the receiving packet. When enough buffer space is released, the PAUSE frame with zero delay is sent.

- Pause Frame must meet all of the following specs:
  - Right DA: DA=0180c2000001 or unicast MAC address belongs to the CPU
  - Right type field = 8808
  - Right op-code = 0001
  - Right CRC

6.1.8 Half Duplex

In half-duplex operation, ADM5120P/PX supports a back pressure feature. If free blocks in the buffer memory are below the threshold, a jam packet (jam mode) is sent to the connected segment, regardless of routing decisions.

6.1.9 Packet Priority and Class of Service (CoS)

ADM5120P/PX can set the packets as high priority via registers as follows:

- Port based priority, refer to register **Priority Control** bits [5:0]
- VLAN tag, refer to registers **VLAN Priority**
- TCP/IP TOS/DS, refer to registers **TOS Enable**, **TOS Map 0** and **TOS Map 1**
- Customer defined type, refer to registers **Custom Priority 1** and **Custom Priority 2**

The priority setting by port means that all the packets received by the port will be priority frames. ADM5120P/PX can also judge the priority of frames by checking the specific bits of VLAN tag or TCP/IP TOS/DS in the frame or the customer defined type.

It will determine the packet priority. First it will check if the packet type meets VLAN or TCP/IP. Then, it will check whether the value of the VLAN tag or the TCP/IP TOS/DS field meets the registers setting. Depending on these two conditions, the scheme of weighted round robin can determine the high and low priority of frames, and thus set the transmitting order.

ADM5120P/PX provides a function to improve the delay-time sensitive traffic in the flow-control condition. When the port receives a priority frame, the back pressure & 802.3x flow control can be turned off until no priority frame occurs within 1 or 2 seconds, then turned back on again. So it can prevent the jitter caused by the flow control and give a better timing-variation result for the priority traffic. This is a register programmable function.

All the packets from the CPU port will be treated as high priority for the switch ports and the best effort result for the CPU traffic will be provided.

6.1.10 VLAN

ADM5120P/PX supports a seven port-grouping VLAN. Each of the VLAN will be treated as isolated ports.For the VLAN grouping setting, refer to the registers **VLAN Group I** and **VLAN Group II**.

ADM5120P/PX provides the VLAN MAC address function, if the packet is assigned with the VLAN address as its destination MAC address, then this packet will be forwarded to the CPU via DMA.

For example, port0 is the WAN port. The others are the LAN ports, then the WAN ports are set as VLAN1 and the others set as VLAN2. The different MAC addresses for the VLAN1/2 are programmed into the address table. Then if the LAN ports receive packets with VLAN2 addresses, the packets will be forward to the CPU via DMA. After processing the packets (like NAT), the CPU can forward the packets to VLAN1.

6.1.11 Address Table Access

ADM5120P/PX provides the access for the embedded MAC address.

- Read - refer to the registers **Search CMD**, **Address ST0** and **Address St1** Issue the search-start command. ADM5120P/PX will automatically search the embedded address table and report the valid one only. If at the end of a table, it will also report the status.
- Write - refer to registers **MAC Write Address 0** and **MAC Write Address 1** Fill in the write address and other information, like port number (or VLAN number), age-time (or static), then issue the write command and wait for the write done bit.

6.1.12 Address Security

The ADM5120P/PX supports the source MAC address security function, register **Port Conf1**(B+2C) bits [31:26]. It can check all-incoming packets in the enable ports – find if the source MAC exists in the MAC address table or not, if not, discard the packets and report the status, register **Port St**(B+18) bits [5:0].

6.1.13 Bandwidth Control Function

ADM5120P/PX can provide the RX/TX separated bandwidth control (or traffic shaping) function, which can be programmed to 64 kbit / 128 kbit / 256 kbit / 512 kbit / 1 Mbit / 4 Mbit / 10 Mbit. Refer the registers **Bandwidth Control 0** and **Bandwidth Control 1**.

In a fixed period, ADM5120P/PX will count the per port RX and TX byte number, and compare with the bandwidth control threshold. If it is over this threshold, ADM5120P/PX will turn on the proprietary scheme to control the RX/TX behavior.

6.1.14 MII Port

The MII port can be programmed for the following: AN monitor on/off, force speed/duplex/flow-control, which can be set by Switch Control Register **Port Conf2**(B+30).The MII direction is also programmable for the following: connect to PHY or MAC, which can be set by Switch Control Register **Port Conf2**(B+30).The default MII mode is normal mode that is 'connect to PHY'. When it is configured to Reverse MII mode. The ADM5120P/PX will output TXC, RXC, CRS and COL. The signals direction will change, and suggest the connection as below:

Table 31 Connection between ADM5120P/PX and MAC Controller

5120P Signal	MAC Signal
RXC	RXC
TXE	RXDV
TXD	RXD
RXDV	TXEN
RXD	TXD
COL	COL
CRS	CRS

6.2 DMA Function Description

The DMA function provides the packets with transmit and receive to/from CPU. There are two priority queues in each path -- transmit and receive. The start address is defined by the base address registers. You can refer to registers in **Send High Base Address**, **Send Low Base Address**, **Receive High Base Address** and **Receive Low Base Address** for details. Every queue is a ring architecture. See the tables for details.

When the packet is put on the data buffer and send descriptor is prepared, software can trigger the DMA to move the data to the internal buffer by setting the **Send Trigger** register.

6.2.1 Send Descriptors Content

If CPU sends the packet to a switch, either LAN or WAN, then the 'send descriptors' are used as follows:

Bit	Bit[31]	Bit[28]	Bit[24:0]	Remark
Type		Control		Controlled by CPU except Own-bit
Function	Own bit	Ring end flag	buffer1_address[24:0]	

Bit	Bit[31]	Bit[24:0]	Remark
Type	Control		Controlled by CPU
Function	buffer2_enable	buffer2_address[24:0]	

Bit		Bit[10:0]	Remark
Type		Control	Controlled by CPU
Function		buffer1_length[10:0]	

Bit	Bit[31]	Bit[26:16]	Bit[13:8]	Bit[5:0]	Remark
Type	Control				Controlled by CPU
Function	append_chksum	pkt-length[10:0]	force desti-port[5:0]	To_VLAN[5:0]	

6.2.1.1 Control

- Own Bit:
  - If 0, the descriptor belongs to CPU. After the data is put in the buffer and control bits are set, this bit will change to 1 to indicate that SW can process this packet.
  - If 1, the descriptor is for SW, and after the data is taken away, then it is loaded to SW data buffer, the bit will be then set to 0.
- Ring end:
  - If 1, the descriptor is the last one, the next descriptor needs to return to the base address.
- Buffer information:
  - Each descriptor can support two buffers.
  - The buffer address can be any byte alignment.
  - Buffer1 has length information, if packet size is larger than buffer1 size, then get the rest of the data from buffer2.
  - Buffer address must be valid when a descriptor belongs to a switch, the switch engine will not check the address status.
  - Buffer2 has an enable bit to control whether the address is valid or not.
  - If the buffer2 is disabled and buffer1 is not long enough, then the remaining data will not be padded 0 to make the packet meet 64-bytes standard.
- Append_chksum: need to append the IP (0800_H) and PPPoE (8864_H) packets IP-checksum by hardware
  - The packet checksum field must be pre-filled with all 0's
- Packet length: the packet length in bytes, excluding CRC if CRC is not padded. (See the register, CPUp_conf)
  - Auto-padding: the engine can automatically pad the 0 into the packet which data size is less than 60 B (or 64). The setting example: buffer 1 size=14, buffer 2 disable, the pkt length=60 (or 64 without CRC padding).

- Force desti-port[5:0]: the packet needs force forwarding to designated ports, and it is the highest priority of routing. If forced, then ignore the routing and To_VLAN flag.
- To_VLAN[5:0]: the bit-map, the packet forwards to the designated VLAN group. Use this flag to control the packets to LAN, WAN, or HPNA ports.

6.2.2 Receive Descriptors Content

If switch sends the packet to CPU, either LAN or WAN, then the 'receive descriptors' are used as follows:

Bit	Bit[31]	Bit[28]	Bit[24:0]	Remark
Type		Control		Controlled by CPU except Own-bit
Function	Own bit	Ring end flag	buffer1_address[24:0]	

Bit	Bit[31]	Bit[24:0]	Remark
Type	Control		Controlled by CPU
Function	buffer2_enable	buffer2_address[24:0]	

Bit		Bit[10:0]	Remark
Type		Control	Controlled by CPU
Function		buffer1_length[10:0]	

Bit	[26:16]	[14:12]		[5:4]	[3]	[2]	[1:0]	Remark
Type	Packet status							Updated by switch
Function	pkt-length[10:0]	Source port number		00: UC01: MC10: BC	IP checksum fail	VLAN tag	00: 0800H01: 8864H11, 10: reserved	

6.2.2.1 Control

- Own bit:
  - If 0, the descriptor belongs to CPU.
  - If 1, the descriptor is released to the WAN MAC or to the LAN SW, which means it can store the incoming packet based on the buffer address. If this is done, change the bit to 0.
- Buffer information:
  - Each descriptor can support two buffers.
  - The buffer address can be any byte alignment.
  - Buffer1 has length information, if packet size is over the buffer1 size, then put the rest of the data into buffer2.
  - Buffer1 address must be valid when descriptor belongs to switch.
  - Buffer2 has a enable bit to control whether the address is valid or not.
  - The buffer2 size must be larger than the remaining data.

– If buffer2 is disabled and buffer1 does not enough space, then the remaining data will be dropped, and no status reported.

6.2.2.2 Status

- Packet length: the packet length in bytes including 4-byte CRC
- Source port: the source port of packet
- DA status:
  – 00: UC, the packet is the forwarded UC packet
  – 01: MC, the packet has 1 in the LSB of first byte of DA
  – 11: BC, the packet has DA=FFFFFFFFFFFF
  – IP checksum fail: if 1 = the IP checksum result is error

Note: Only checked if type = 0800_H (IP) or 8864_H (PPPoE)

- The VLAN tagged frame status (type = 8100_H)
- Packet type:
  – 00: type = 0800_H, IP
  – 01: type = 8864_H, PPPoE
  – 10,11 reserved

6.3 Switch Control Register Map

Although some registers may be marked with a certain type, it may be possible that some bits in this register are different. This is explained in the register description.

Table 32 Registers Address Space

Module	Base Address	End Address	Note
Switch Control	1200 0000$_H$	1200 0110$_H$	–

Table 33 Registers Overview

Register Short Name	Register Long Name	Offset Address	Page Number
Code	Code	00$_H$	110
Sft_Res	Software Reset	04$_H$	111
Boot_D	Boot Done	08$_H$	112
SW_Res	Software Reset	0C$_H$	112
GI_St	Global St	10$_H$	112
PHY_St	PHY St	14$_H$	113
Port_St	Port St	18$_H$	114
Mem_Cont	Memory Control	1C$_H$	116
SW_conf	SW Conf	20$_H$	117
CPUp_conf	CPUp Conf	24$_H$	119
Port_conf0	Port Conf0	28$_H$	120
Port_conf1	Port Conf1	2C$_H$	121
Port_conf2	Port Conf2	30$_H$	122
Res_1	Reserved 1	34$_H$	123
Res_2	Reserved 2	38$_H$	124
Res_3	Reserved 3	3C$_H$	124
VLAN_GI	VLAN Group I	40$_H$	125
VLAN_GII	VLAN Group II	44$_H$	126
Send_trig	Send Trigger	48$_H$	126
Srch_cmd	Search CMD	4C$_H$	126
ADDR_st0	Address ST0	50$_H$	128
ADDR_st1	Address St1	54$_H$	129
MAC_wt0	MAC Write Address 0	58$_H$	129
MAC_wt1	MAC Write Address 1	5C$_H$	129
BW_cntl0	Bandwidth Control 0	60$_H$	130
BW_cntl1	Bandwidth Control 1	64$_H$	131
PHY_cntl0	PHY Control 0	68$_H$	132
PHY_cntl1	PHY Control 1	6C$_H$	133
FC_th	Switch Control Threshold	70$_H$	133
adj_port_th	Adj Port Threshold	74$_H$	133
Port_th	Port Threshold	78$_H$	135
PHY_cntl2	PHY Control 2	7C$_H$	135
PHY_cntl3	PHY Control 3	80$_H$	136

Table 33 Registers Overview (cont'd)

Register Short Name	Register Long Name	Offset Address	Page Number
Pri_cntl	Priority Control	84_H	137
VLAN_pri	VLAN Priority	88_H	138
TOS_en	TOS Enable	$8C_H$	139
TOS_map0	TOS Map 0	90_H	139
TOS_map1	TOS Map 1	94_H	139
Custom_pri1	Custom Priority 1	98_H	140
Custom_pri2	Custom Priority 2	$9C_H$	140
PHY_cntl4	PHY Control 4	$A0_H$	142
Empty_cnt	Empty Control	$A4_H$	142
Port_cnt_sel	Port Control Select	$A8_H$	144
Port_cnt	Port Controller	AC_H	145
Int_st	Int St	$B0_H$	146
Int_mask	Interrupt Mask	$B4_H$	147
GPIO_conf0	GPIO Conf 0	$B8_H$	149
GPIO_conf2	GPIO Conf 2	BC_H	149
Wdog_0	Watchdog 0	$C0_H$	151
Wdog_1	Watchdog 1	$C4_H$	152
Swap_in	Swap In	$C8_H$	153
Swap_out	Swap Out	CC_H	153
send_Hbaddr	Send High Base Address	$D0_H$	153
send_Lbaddr	Send Low Base Address	$D4_H$	154
rec_Hbaddr	Receive High Base Address	$D8_H$	155
rec_Lbaddr	Receive Low Base Address	DC_H	155
send_Hwaddr	Send High Working Address	$E0_H$	156
send_Lwaddr	Send Low Working Address	$E4_H$	156
rec_Hwaddr	Receive High Working Address	$E8_H$	157
rec_Lwaddr	Receive Low Working Address	EC_H	157
Timer_int	Timer Interrupt	$F0_H$	158
Timer	Timer	$F4_H$	159
Res_4	Reserved 4	$F8_H$	160
Res_5	Reserved 5	FC_H	161
port0_LED	Port 0 LED	100_H	161
port1_LED	Port 1 LED	104_H	162
port2_LED	Port 2 LED	108_H	164
port3_LED	Port 3 LED	$10C_H$	165
port4_LED	Port 4 LED	110_H	166

The register is addressed wordwise.

Table 34 Registers Access Types

Mode	Symbol	Description Hardware (HW)	Description Software (SW)
Basic Access Types			
read/write	rw	Register is used as input for the HW	Register is read and writable by SW
read/write virtual	rwv	Physically, there is no new register in the generated register file. The real readable and writable register resides in the attached hardware.	Register is read and writable by SW (same as rw type register)
read	r	Register is written by HW (register between input and output -> one cycle delay)	Value written by SW is ignored by HW; that is, SW may write any value to this field without affecting HW behavior
read only	ro	Same as r type register	Same as r type register
read virtual	rv	Physically, there is no new register in the generated register file. The real readable register resides in the attached hardware.	Value written by SW is ignored by HW; that is, SW may write any value to this field without affecting HW behavior (same as r type register)
write	w	Register is written by software and affects hardware behavior with every write by software.	Register is writable by SW. When read, the register does not return the value that has been written previously, but some constant value instead.
write virtual	wv	Physically, there is no new register in the generated register file. The real writable register resides in the attached hardware.	Register is writable by SW (same as w type register)
read/write hardware affected	rwh	Register can be modified by hardware and software at the same time. A priority scheme decides, how the value changes with simultaneous writes by hardware and software.	Register can be modified by HW and SW, but the priority SW versus HW has to be specified. SW can read the register.

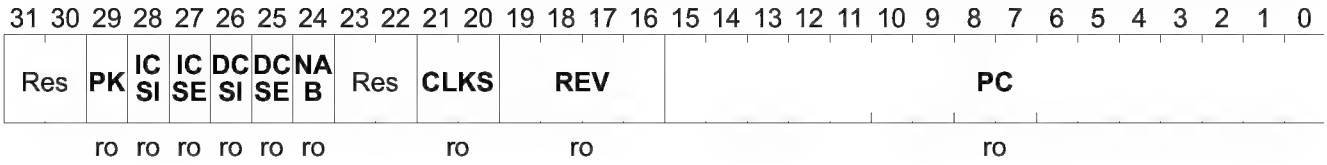
Table 35 Registers Clock Domains

Clock Short Name	Description
–	–

6.3.1 Registers Description

Code

Code	Offset	Reset Value
Code	00_H	12085120_H

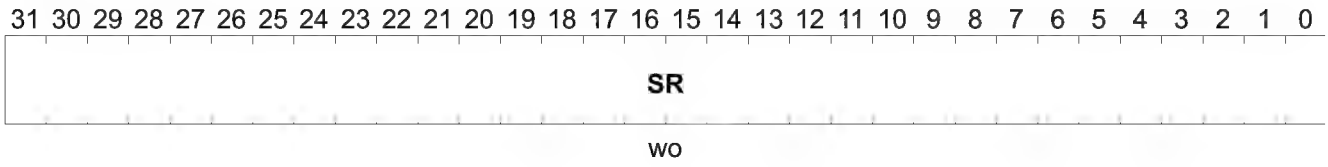


Field	Bits	Type	Description
Res	31:30		**Reserved** Not Applicable.
PK	29	ro	**Package type** 0_B BGA 1_B 208 PQFP
ICSI	28	ro	**Icache Size** 0_B 1 Way 1_B 2 Ways
ICSE	27	ro	**Icache Set** 0_B 4K per way 1_B 2K per way
DCSI	26	ro	**Dcache Size** 0_B 1 Way 1_B 2 Ways
DCSE	25	ro	**Dcache Set** 0_B 4K per way 1_B 2K per way
NAB	24	ro	**NAND Boot** Configured in the NAND flash boot.
Res	23:22		**Reserved**
CLKS	21:20	ro	**Clock SPD** The PLL setting. 00_B 175 MHz (Default) 01_B Reserved $1x_B$ Reserved
REV	19:16	ro	**Revision** Revision code = 1000
PC	15:0	ro	**Product Code** Product code = 5120H

Software Reset

Note: Whenever you write the register offset 04_H, the SftReset will be active.

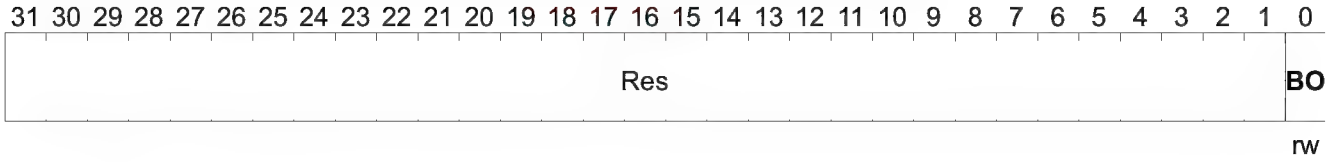
Sft_Res	Offset	Reset Value
Software Reset	04_H	1_H



Field	Bits	Type	Description
SR	31:0	wo	**Software Reset** Do Software reset when write, reset all logic, PHY and memory, and down load the NAND flash content again. Same as hardware reset.

Boot Done

Boot_D	Offset	Reset Value
Boot Done	08_H	0_H

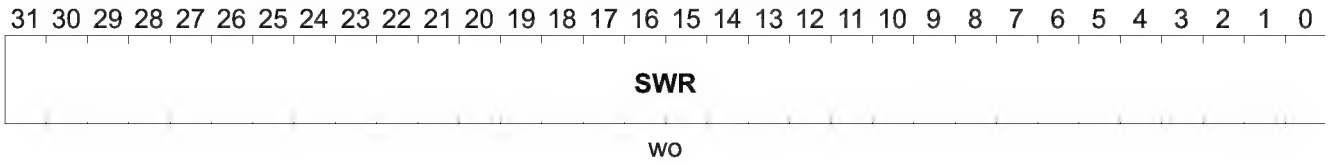


Field	Bits	Type	Description
Res	31:1		**Reserved**
BO	0	rw	**Boot** 1_B The software boot process is done and the address table can return to the switch controller.

Switch Reset

Note: Whenever you write the register offset $0C_H$ the SWReset will be active.

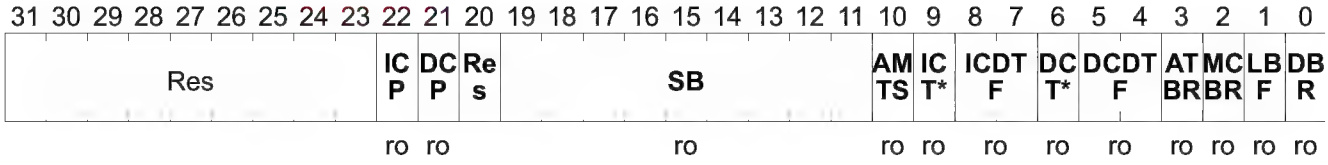
SW_Res	Offset	Reset Value
Software Reset	$0C_H$	1_H



Field	Bits	Type	Description
SWR	31:0	wo	**Switch Reset** Do Switch reset when write, including Switch engine, data-buffer, link table, and PHY excluding address table. (Recommend stop PHY before reset switch).

Global St

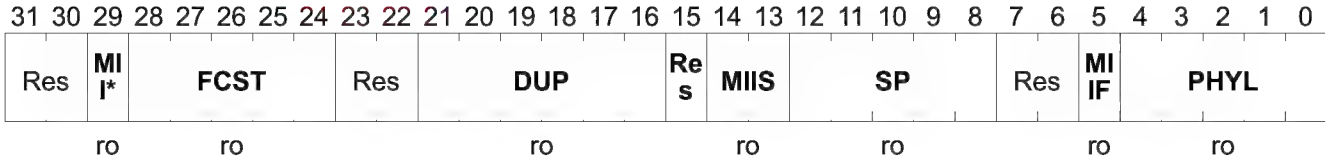
Gl_St	Offset	Reset Value
Global St	10_H	400_H



Field	Bits	Type	Description
Res	31:23		**Reserved** Not Applicable.
ICP	22	ro	**Icache Portion** For debugging purpose of embedded SRAM.
DCP	21		**Dcache Portion** For debugging purpose of embedded SRAM.
Res	20		**Reserved**
SB	19:11	ro	**Skip Blocks** The number of block is skipped up to 64 blocks.
AMTS	10	ro	**All Embedded Memory Test Completed** 1_B Complete
ICTTF	9	ro	**Icache Tag Test Fail** The memory of I-cache tag. 0_B Pass
ICDTF	8:7	ro	**Icache Data Test Fail** Bit 8 and Bit 7 are respectively for the upper and lower 32-bit of I-cache memory for data. 00_B Pass
DCTTF	6	ro	**Dcache Tag Test Fail** The memory of D-cache tag. 0_B Pass
DCDTF	5:4	ro	**Dcache Data Test Fail** Bit 5 and Bit 4 are respectively for the upper and lower 32-bit of D-cache memory for data. 00_B Pass
ATBR	3	ro	**Address Table BIST Result** 0_B Pass
MCBR	2	ro	**MC Table BIST Result** 0_B Pass
LBF	1	ro	**Link Table BIST Result** 0_B Pass
DBR	0	ro	**Data Buffer BIST Result** 0_B Pass

PHY St

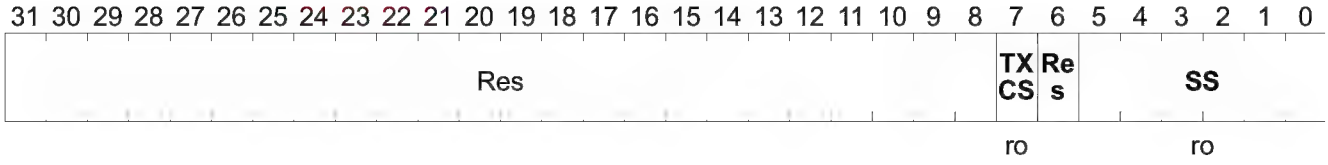
PHY_St	Offset	Reset Value
PHY St	14_H	0_H



Field	Bits	Type	Description
Res	31:30		**Reserved** Not Applicable.
MII_FC	29	ro	**FC Status of MII Port** It is used for flow control status. 0_B FC off 1_B FC on
FCST	28:24	ro	**FC** Bit [28:24] represent PHY port [4:0] flow control status respectively. 1_B Full duplex and 802.3x flow control ON (after AN or forced).
Res	23:22		**Reserved** Not Applicable.
DUP	21:16	ro	**Duplex** 0_B Half duplex 1_B Full duplex
Res	15		**Reserved** Not Applicable.
MIIS	14:13	ro	**MII Port Speed** 00_B 10M 01_B 100M $0x_B$ Reserved
SP	12:8	ro	**Speed** 0_B 10M 1_B 100M
Res	7:6		**Reserved** Not Applicable.
MIIF	5	ro	**MII Fail** 0_B Port fail 1_B Link ok
PHYL	4:0	ro	**PHY Link** Bit[4:0] represent PHY port[4:0] link status respectively 0_B Down 1_B Up

Port St

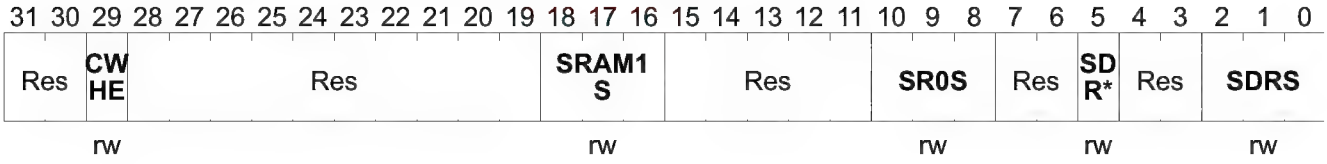
Port_St	Offset	Reset Value
Port St	**18_H**	**0_H**



Field	Bits	Type	Description
Res	31:8		**Reserved** Not Applicable.
TXCS	7	ro	**TXC St, MII Port TXC Status** 1_B Error, no TXC or too long period
Res	6		**Reserved** Not Applicable.
SS	5:0	ro	**Security Status** 1_B Has intruder coming if so turn on the SA_secured mode

Memory Control

Mem_Cont	Offset	Reset Value
Memory Control	$1C_H$	204_H



Field	Bits	Type	Description
Res	31:30		**Reserved** Not Applicable.
CWHE	29	rw	**CSX0 Write Hold Extend** Extend the write data hold time from one clock to 3 clock (clock period = CLK_OUT). 0_B Normal, 1 clock, default 1_B Extend to 3 clocks
Res	28:19		**Reserved** Not Applicable.
SRAM1S	18:16	rw	**SRAM1 Size** 000_B Disable (default) 001_B 512 Kbyte 010_B 1 Mbyte 011_B 2 Mbyte 100_B 4 Mbyte 101_B 8 Mbyte 110_B Reserved 111_B Reserved
Res	15:11		**Reserved** Not Applicable.
SR0S	10:8	rw	**SRAM0 Size** 000_B Disable if in the NAND mode 001_B 512 Kbyte 010_B 1 Mbyte (default) 011_B 2 Mbyte 100_B 4 Mbyte 110_B Reserved 111_B Reserved
Res	7:6		**Reserved** Not Applicable.
SDR1E	5	rw	**SDRAM1 Enable** The bank1 of SDRAM enable. 0_B Disable (default) 1_B Enable (must in the single write)

Field	Bits	Type	Description
Res	4:3		**Reserved** Not Applicable.
SDRS	2:0	rw	**SDRAM Size** One bank information, the 2nd bank (SDRAM_CS1) is the same. 000_B Reserved 001_B 1M x 32 (4 Mbyte) 010_B 2M x 32 (8 Mbyte) (suggested setting) 011_B 4M x 32 (16 Mbyte) 100_B 16M x 32 (64 Mbyte) 101_B 32M x 32 (128 Mbyte) 110_B Reserved 111_B Reserved

SW_conf

SW_conf	Offset	Reset Value
SW Conf	20_H	$402A1010_H$

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
REQL				BITH		BID	MPDT	BIS*	RMCF	BPM		BPJN				DCBT	HA		DC	MPL		BCP		AGT				Res			
rw				rw		rw	rw	rw	rw	rw		rw				rw	rw		rw	rw		rw		rw							

Field	Bits	Type	Description
REQL	31:28	rw	**AHB Request Latency** The minimum number of cycles between the AHB bus request. 4_B 4 clocks latency between requests
BITH	27:26	rw	**The Threshold of BISS** 00_B Skip if fail 16 (default from pins) 01_B Skip if fail 48 10_B Skip if fail 64 11_B Skip if fail 8 blocks
BID	25	rw	**Build-in Self Skip Disable** 0_B Enable skip function (default, from pin A[6])
MPDT	24	rw	**MII0 Port Disable was Transmit** 0_B Enable 1_B Disable was_transmit (good for late CRS PHY, like HPNA2.0 or power-LAN)
BISRD	23	rw	**Build-in Self Repair Disable** 0_B Enable skip function (default, from pin A[5])

Field	Bits	Type	Description
RMCF	22	rw	**Reserved MC Filtering** *Note: Reserved MC = 01-80-c2-00-00-00 (BPDU) and 01-80-c2-00-00-02 to 01-80-c2-00-00-0f* 0_B Forwarded 1_B Filtered
BPM	21:20	rw	**Back Pressure Mode** 00_B Disable 01_B BP jam, the jam number is set by BP_num 10_B BP jamALL, jam packet until the BP condition is released (default), 11_B BP carrier, use carrier insertion to do back pressure
BPJN	19:16	rw	**Back Pressure Jam Number** The consecutive jam time when back pressured. 1010_B Default value, 10 packet jam then one no-jam
DCBT	15	rw	**Disable the Collision Back off Timer** 0_B Follow standard 1_B Re-transmit immediately after collision
HA	14:13	rw	**MAC Address Hashing Algorithm** 00_B Direct mode, using last 10 bits as hashing address 01_B XOR48 mode 10_B XOR32 mode 11_B Reserved
DC	12	rw	**Disable Collision** 1_B Disable collision 16 packet abort
MPL	11:10	rw	**Maximum Packet Length** 00_B 1536 01_B 1518 10_B 1522 11_B Reserved
BCP	9:8	rw	**Broadcast Prevention** 00_B Disable, BC will be blocked 01_B 64 blocks 10_B 48 blocks 11_B 32 blocks
AGT	7:4	rw	**Aging Timer** 0000_B Disable age 0001_B 300 s 0010_B 600 ..... 0111_B 38400 s $1xxx_B$ Fast age
Res	3:0		**Reserved** Not Applicable.

CPUp_conf

CPUp_conf	Offset	Reset Value
CPUp Conf	24_H	$3F3F7E01_H$

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res				DBCP				Res				DMCP				Res	DUNP						Res							BTM	CRCP	DCP*
rw				rwr								rw					rw												rw	rw	rw

Field	Bits	Type	Description
Res	31:30	rw	**Reserved** Not Applicable
DBCP	29:24	rwr	**Disable Broadcast Packets, from port(s), Forward to CPU** The bit [29:24] controls the MII port and PHY port [4:0] respectively. 1_B Disable sending BC from the MAC port to CPU
Res	23:22		**Reserved** Not Applicable
DMCP	21:16	rw	**Disable Multicast Packets, from Port(s), Forward to CPU** The bit [21:16] controsl the MII port and PHY port [4:0] respectively. 1_B No send MC from the MAC port to CPU
Res	15		**Reserved** Not Applicable
DUNP	14:9	rw	**Disable Unknown Packets, from Port(s), Forward to CPU** The bit [14:9] controls the MII port and PHY port [4:0] respectively. 1_B No send unknown packet from the MAC port to CPU
Res	8:3		**Reserved** Not Applicable
BTM	2	rw	**Bridge Testing Mode** 0_B Default 1_B Forwards to CPU if the DA is the port belonging to the other VLAN (for the bridge mode testing).
CRCP	1	rw	**CRC Padding from CPU** 1_B The packet from CPU with CRC
DCPUP	0	rw	**Disable CPU Port** 1_B Disable the switch CPU port, and so send packets to CPU and clear all the packets in the switch buffer.

Port_conf0

Port_conf0	Offset	Reset Value
Port Conf0	28_H	$3F3F3F_H$

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res										**EBP**						Res		**EMCP**						Res		**DP**					
										rw								rw								rw					

Field	Bits	Type	Description
Res	31:22		**Reserved** Not Applicable.
EBP	21:16	rw	**Enable Back Pressure** 1_B Enable back pressure (but need qualify BP_mode)
Res	15:14		**Reserved** Not Applicable.
EMCP	13:8	rw	**Enable All MC Packet** Enable all MC packet broadcast to ports in the same VLAN (not including CPU). 1_B Enable Layer2 MC broadcast to ports 0_B do not broadcast MC
Res	7:6		**Reserved** Not Applicable
DP	5:0	rw	**Disable Port** 1_B Port disable (if dumb mode, default = 0)

Port_conf1

Port_conf1	Offset	Reset Value
Port Conf1	$2C_H$	$3F00000_H$

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SASM						PA						Res		BM						BS						DisL					
rw						rw								rw						rw						rw					

Field	Bits	Type	Description
SASM	31:26	rw	**SA Secured Mode** **Notes** *1. Set Dis_Learn and SA_secured at the same time, then only forward the packets with the SA and port number matched.* *2. 2. set SA_secured only, then no any secured function* 0_B Don't care SA match 1_B The packets' SA need match, otherwise discard the packets
PA	25:20	rw	**Port Aging** 1_B Enable aging 0_B Disable aging that the MAC address is belong to Programmed port(s)
Res	19:18		**Reserved** Not Applicable.
BM	17:12	rw	**Blocking Mode** If in blocking state. 0_B Forward all packets to CPU 1_B Only forward control packets to CPU
BS	11:6	rw	**Blocking State** Only do the forwarding to CPU, and no learning, and no transmitting (except the packet from CPU). 0_B Normal state 1_B Block state
DisL	5:0	rw	**Dis Learn** Stop SA learning. 0_B Enable SA learn

Port_conf2

Port_conf2	Offset	Reset Value
Port Conf2	30_H	$10C_H$

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res								DUPF						LEDFT		Res							TXCC	RMII*	Res	FMPFC		FMPD	FMPS		MII*
														rw									rw	rw		rw		rw	rw		rw

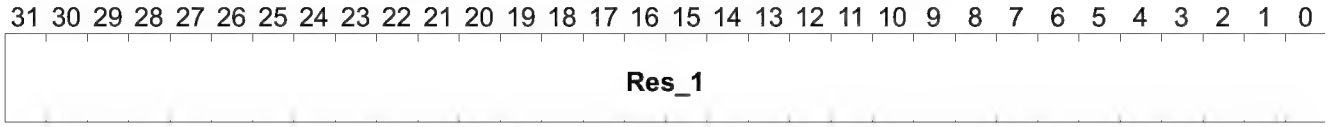
Field	Bits	Type	Description
Res	31:24		**Reserved** Not Applicable.
DUPF	23:18		**Disable Unicast Pause Frame 5:0** 00000_B Default value
LEDFT	17:16	rw	**The Frequency of LED Flash** 00_B 30 ms 01_B 60 ms 10_B 240 ms 11_B 480 ms
Res	15:9		**Reserved** Not Applicable.
TXCC	8	rw	**TXC Check** Check the MII port TXC period, if more than 400 µs, then disable MII port 0_B Enable check 1_B Disable check TXC (only for 10/100M) (default)
RMIIM	7	rw	**Reversed MII Mode** 0_B Normal MII mode (default) 1_B Enable (if in the dumb mode set to 1)
Res	6		**Reserved** Not Applicable.
FMPFC	5:4	rw	**Force MII port FC** Force MII port 802.3x flow control ON if AN monitor disable. 00_B No forced 01_B Forced the FC of 10M/100M $1x_B$ Reserved
FMPD	3	rw	**Force MII Port Duplex if AN Monitor Disable** 0_B Forced in half duplex 1_B Forced in full duplex
FMPS	2:1	rw	**Force MII Port Speed if AN Monitor Disable** 00_B Force d in 10M 01_B Forced in 100M 10_B Reserved 11_B Reserved

Field	Bits	Type	Description
MIIAN	0	rw	**MII Port AN Monitor Enable** 0_B Disable 1_B Enable MII AN monitor via MDIO (if in the dumb mode, set to 1)

Reserved 1

Res_1 **Offset** **Reset Value**

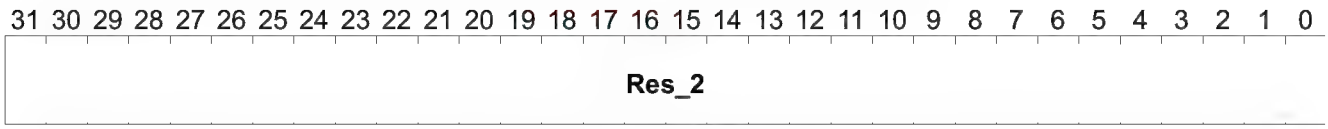
Reserved 1 **34_H** **0_H**



Field	Bits	Type	Description
Res_1	31:0		**Reserved** Not Applicable.

Reserved 2

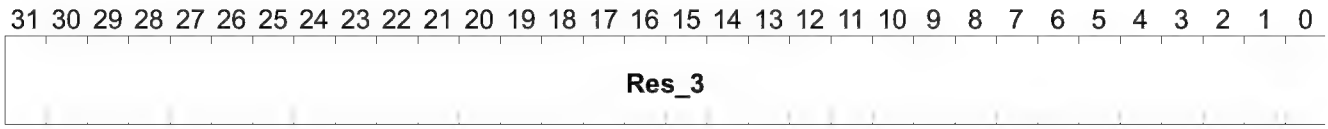
Res_2	Offset	Reset Value
Reserved 2	38_H	0_H



Field	Bits	Type	Description
Res_2	31:0		**Reserved** Not Applicable.

Reserved 3

Res_3	Offset	Reset Value
Reserved 3	$3C_H$	0_H



Field	Bits	Type	Description
Res_3	31:0		**Reserved** Not Applicable.

VLAN Group I

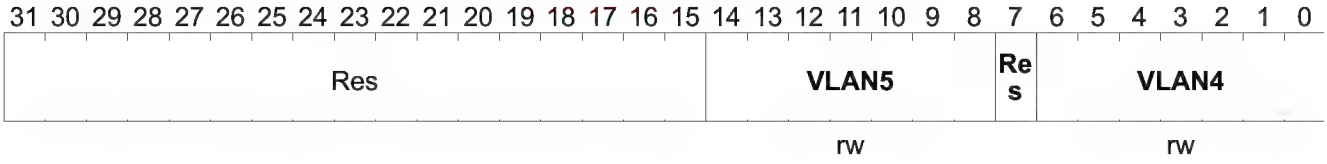
VLAN_GI	Offset	Reset Value
VLAN Group I	40_H	$7F_H$

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res	VLAN3							Res	VLAN2							Res	VLAN1							Res	VLAN0						
	rw								rw								rw								rw						

Field	Bits	Type	Description
Res	31		**Reserved** Not Applicable.
VLAN3	30:24	rw	**VLAN Group 3** The ports in VLAN group 3, 0000000
Res	23		**Reserved** Not Applicable.
VLAN2	22:16	rw	**VLAN Group 2** The ports in VLAN group 2, 0000000
Res	15		**Reserved** Not Applicable.
VLAN1	14:8	rw	**VLAN Group 1** The ports in VLAN group 1, 0000000
Res	7		**Reserved** Not Applicable.
VLAN0	6:0	rw	**VLAN Group 0** The ports in VLAN group 0, the 6 th bit is CPU port. 1111111_B All ports in the VLAN group 0

VLAN Group II

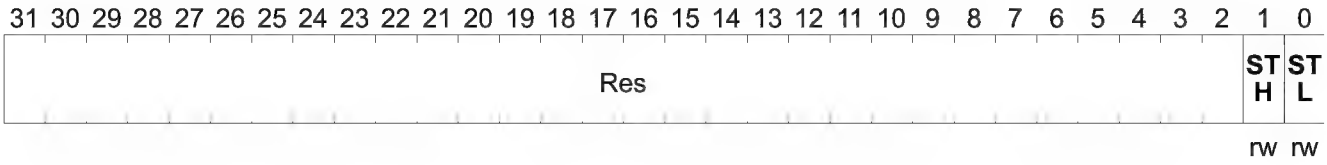
VLAN_GII	Offset	Reset Value
VLAN Group II	44_H	0_H



Field	Bits	Type	Description
Res	31:15		**Reserved** Not Applicable.
VLAN5	14:8	rw	**VLAN Group 5** The ports in VLAN group 5, 0000000
Res	7		**Reserved** Not Applicable.
VLAN4	6:0	rw	**VLAN Group 4** The ports in VLAN group 4, 0000000

Send Trigger

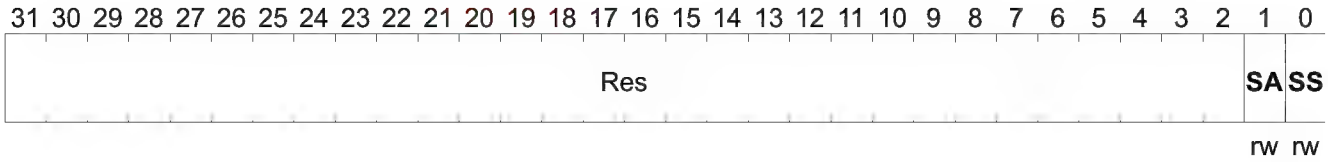
Send_trig	Offset	Reset Value
Send Trigger	48_H	0_H



Field	Bits	Type	Description
Res	31:2		**Reserved** Not Applicable.
STH	1	rw	**Send Trigger High** CPU Send packet to LAN/WAN DMA trigger (high priority), self_clear
STL	0	rw	**Send Trigger Low** CPU Send packet to LAN/WAN DMA trigger (normal priority), self_clear

Search CMD

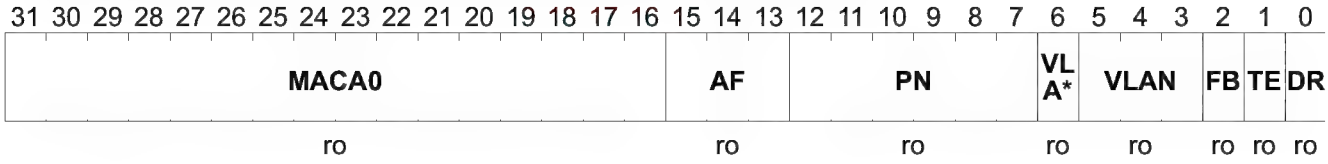
Srch_cmd	Offset	Reset Value
Search CMD	$4C_H$	0_H



Field	Bits	Type	Description
Res	31:2		**Reserved** Not Applicable.
SA	1	rw	**Search Again** Search for the next available address, self_clear (program again after data_rdy).
SS	0	rw	**Search Start** Searching from the start of address table, self_clear.

Address ST0

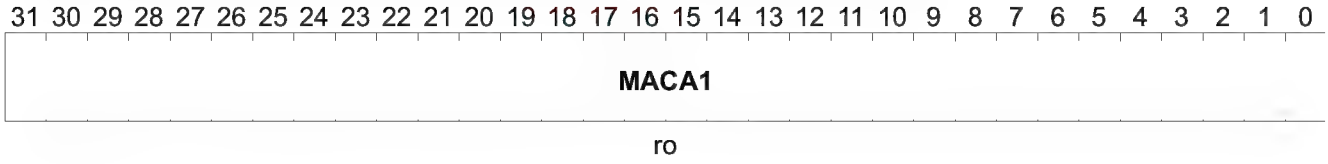
ADDR_st0	Offset	Reset Value
Address ST0	50_H	0_H



Field	Bits	Type	Description
MACA0	31:16	ro	**MAC Address 15:0**
AF	15:13		**Age Field** 000_B Empty 001 to 110_B Existing MAC 111_B Static address
PN	12:7		**Port Map Number** Port number (refer to B+58, bit7-12)
VLANE	6		**VLAN Field is Enabled**
VLAN	5:3		**VLAN Number**
FB	2		**Filter Bit**
TE	1		**Search to Table End** 1_B Hit the end of MAC address table
DR	0		**Data is Ready** ADDR_st, ADDR_srch0 and ADDR_srch1 are ready, read_clear

ADDR St1

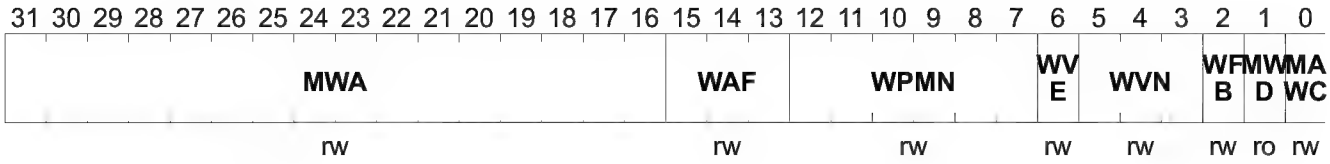
ADDR_st1 **Offset** **Reset Value**
Address St1 **54_H** **0_H**



Field	Bits	Type	Description
MACA1	31:0	ro	**MAC Address 47:16**

MAC Write Address 0

MAC_wt0 **Offset** **Reset Value**
MAC Write Address 0 **58_H** **0_H**



Field	Bits	Type	Description
MWA	31:16	rw	**MAC Write Address 15:0**
WAF	15:13	rw	**Write Age Field** 000_B Empty 001 to 110_B Existed MAC 111_B Static address
WPMN	12:7	rw	**Write Port Map Number**
WVE	6	rw	**Write VLAN Enable**
WVN	5:3	rw	**Write VLAN Number**
WFB	2	rw	**Write Filter Bit**
MWD	1	ro	**MAC Write Done** 1_B MAC address write complete, read_clear
MAWC	0	rw	**MAC Address Write Command** 1_B The MAC write data is ready and write toMAC table, self_clear

MAC Write Address 1

MAC_wt1 **Offset** **Reset Value**
MAC Write Address 1 **$5C_H$** **0_H**

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MWA																															
rw																															

Field	Bits	Type	Description
MWA	31:0	rw	**MAC Write Address 47:16**

Bandwidth Control 0

BW_cntl0 **Offset** **Reset Value**
Bandwidth Control 0 **60_H** **0_H**

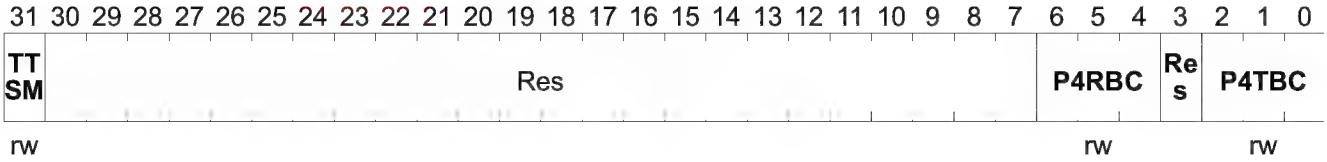
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res	P3RBC			Res	P3TBC			Res	P2RBC			Res	P2TBC			Res	P1RBC			Res	P1TBC			Res	P0RBC			Res	P0TBC		
	rw				rw				rw				rw				rw				rw				rw				rw		

Field	Bits	Type	Description
Res	31		**Reserved** Not Applicable.
P3RBC	30:28	rw	**Port 3 Receive Bandwidth Control** 000_B Disable 001_B 64K bit per second 010_B 128K bit per second 011_B 256K bit per second 100_B 512K bit per second 101_B 1M bit per second 110_B 4M bit per second 111_B 10M bit per second
Res	27		**Reserved** Not Applicable.

Field	Bits	Type	Description
P3TBC	26:24	rw	**Port 3 Transmit Bandwidth Control** 000_B Disable 001_B 64K bit per second 010_B 128K bit per second 011_B 256K bit per second 100_B 512K bit per second 101_B 1M bit per second 110_B 4M bit per second 111_B 10M bit per second
Res	23		**Reserved** Not Applicable.
P2RBC	22:20	rw	**Port 2 Receive Bandwidth Control** Please refer to **P3RBC** for bandwidth define.
Res	19		**Reserved** Not Applicable.
P2TBC	18:16	rw	**Port 2 Transmit Bandwidth Control** Please refer to **P3RBC** for bandwidth define.
Res	15		**Reserved** Not Applicable.
P1RBC	14:12	rw	**Port 1 Receive Bandwidth Control** Please refer to **P3RBC** for bandwidth define.
Res	11		**Reserved** Not Applicable.
P1TBC	10:8	rw	**Port 1 Transmit Bandwidth Control** Please refer to**P3RBC** for bandwidth define.
Res	7		**Reserved** Not Applicable.
P0RBC	6:4	rw	**Port 0 Receive Bandwidth Control** Please refer to **P3RBC** for bandwidth define.
Res	3		**Reserved** Not Applicable.
P0TBC	2:0	rw	**Port 0 Transmit Bandwidth Control** 000_B Disable 001_B 64K bit per second 010_B 128K bit per second 011_B 256K bit per second 100_B 512K bit per second 101_B 1M bit per second 110_B 4M bit per second 111_B 10M bit per second

Bandwidth Control 1

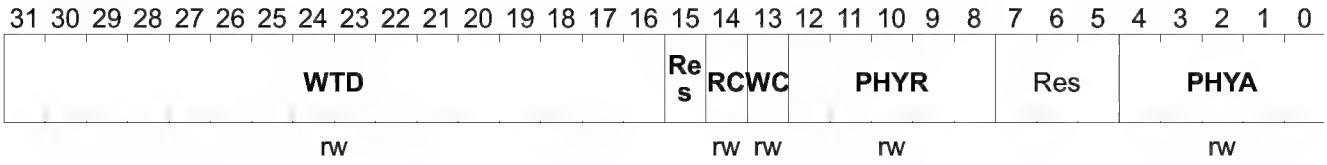
BW_cntl1	Offset	Reset Value
Bandwidth Control 1	**64_H**	**0_H**



Field	Bits	Type	Description
TTSM	31	rw	**The Transmit Traffic Shaper Mode** 0_B Best effort mode (default) 1_B Average Inter Packet Gap (IPG) in the 1 second period
Res	30:7		**Reserved** Not Applicable.
P4RBC	6:4	rw	**Port 4 Receive Bandwidth Control** Please refer to **P3RBC** for bandwidth define.
Res	3		**Reserved** Not Applicable.
P4TBC	2:0	rw	**Port 4 Transmit Bandwidth Control** Please refer to **P3RBC** for bandwidth define.

PHY Control 0

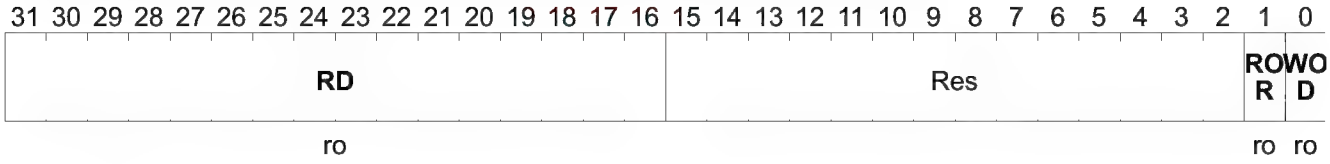
PHY_cntl0	Offset	Reset Value
PHY Control 0	**68_H**	**0_H**



Field	Bits	Type	Description
WTD	31:16	rw	**The Data be Written into the PHY**
Res	15		**Reserved** Not Applicable.
RC	14	rw	**Read Command, self_clear**
WC	13		**Write Command, self_clear**
PHYR	12:8		**PHY Register Address**
Res	7:5		**Reserved** Not Applicable.
PHYA	4:0	rw	**PHY Address**

PHY Control 1

PHY_cntl1	Offset	Reset Value
PHY Control 1	$6C_H$	0_H

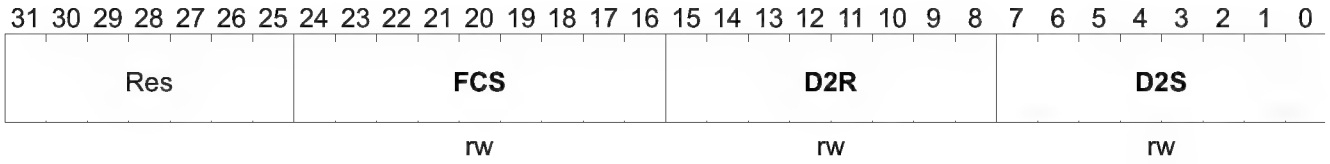


Field	Bits	Type	Description
RD	31:16	ro	**The Read Data**
Res	15:2		**Reserved** Not Applicable.
ROR	1	ro	**Read Operation is Complete and Data is Ready, read_clear**
WOD	0		**Write Operation is Done, read_clear**

Switch Control Threshold

*Note: The working global thresholds = (register value) * 2, The Drop1_set[7:0] threshold default value = 137 blocks, The default working Drop1_set threshold = 137 x 2 =274.*

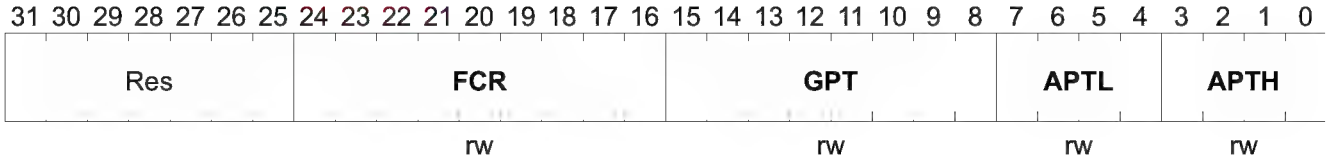
FC_th	Offset	Reset Value
Switch Control Threshold	70_H	$DC866A_H$



Field	Bits	Type	Description
Res	31:25		**Reserved** Not Applicable.
FCS	24:16	rw	**Switch Flow Control Set Threshold, 220 Free Blocks**
D2R	15:8		**Switch Drop 2 Release Threshold, 134 Free Blocks**
D2S	7:0		**Switch Drop 2 Set Threshold, 106 Free Blocks**

Adj Port Threshold

adj_port_th	Offset	Reset Value
Adj Port Threshold	74_H	$10C2033_H$



Field	Bits	Type	Description
Res	31:25		**Reserved** Not Applicable.
FCR	24:16	rw	**Switch Flow Control Release Threshold, 268 Free Blocks**
GPT	15:8	rw	**Giga Port Buffer Threshold, 32 Occupied Blocks**
APTL	7:4	rw	**Per Port Guaranteed High Priority pkt, 3 Blocks**
APTH	3:0		**Per Port Guaranteed Normal Priority pkt, 3 Blocks**

Port Threshold

Port_th	Offset	Reset Value
Port Threshold	78_H	$8478300D_H$

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
CPURT								CPUHT								CPU_th								PPT							
rw								rw								rw								rw							

Field	Bits	Type	Description
CPURT	31:24	rw	**The CPU Hold Release Threshold, Default 132 Free Block**
CPUHT	23:16		**The CPU Hold Threshold for All Ports, Default 120 Free Block**
CPU_th	15:8		**CPU Port Buffer Threshold, 48 Occupied Blocks**
PPT	7:0		**Per Port Buffer Threshold, 13 Occupied Blocks**

PHY Control 2

PHY_cntl2	Offset	Reset Value
PHY Control 2	$7C_H$	$BE0FFFFF_H$

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res	RMAE	AMDIX						PHYR								RFCV								DC							
rw	rw	rw						rw								rw								rw							

Field	Bits	Type	Description
Res	31		**Reserved** Not Applicable.

Field	Bits	Type	Description
RMAE	30	rw	**Recommend MCC Average Enable** Per port PHY auto MDIX enable. 0_B Default value
AMDIX	29:25		**Auto MDIX enable** *Note: [25] = port0, [26] = port 1 etc…* 0_B disable auto MDIX. 1_B enable auto MDIX. (default)
PHYR	24:20		**PHY Reset** *Note: [20] = port0, [21] = port 1 etc…* 0_B Reset(default) 1_B Normal
RFCV	19:15		**Recommended FC Value (reg4, bit10)** *Note: [15] = port0, [16] = port 1 etc…* 0_B No forced 1_B FC_rec ON
DC	14:10		**Duplex Control** *Note: [10] = port0, [11] = port 1 etc…* 0_B Half 1_B Full
SC	9:5		**Speed Control** *Note: [5] = port0, [6] = port 1 etc…* 0_B 10M 1_B 100M
ANE	4:0		**Auto Negotiation Enable** *Note: [0] = port0, [1] = port 1 etc…* 1_B Enable

PHY Control 3

PHY_cntl3	Offset	Reset Value
PHY Control 3	80_H	$1420B_H$

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res												FXE			DFE*	CBDE	RPIC	RPLFT		RFGL	RNT	RTJD	RRJE	RAPD	IIN*	RSHC		PFRV		RBLL	
												rw			rw	rw	rw	rw		rw	rw	rw	rw	rw	rw	rw		rw		rw	

Field	Bits	Type	Description
Res	31:22		**Reserved** Not Applicable.

Field	Bits	Type	Description
FXE	21:17	rw	**Per Port FX Enable** *Note: [17] = port0, [18] = port 1 etc…* 0_B Default value, disable 1_B Enable FX
DFEFI	16		**Disable far_end Fault Indication**
CBDE	15		**Recommend Cable Broken Detect Enable**
RPIC	14		**Recommend Polarity LIU/LID Interval Check**
RPLFT	13:12		**Recommend Polarity Link Fail Timer Select** 00_B Default value (2 sec.) 01_B 3 sec. 10_B 4 sec. 11_B 8 sec.
RFGL	11		**Recommend Force Good Link**
RNT	10		**Recommend Normal Threshold**
RTJD	9		**Recommend Tansmit Jabber Disable**
RRJE	8		**Recommend Receive Jabber Enable**
RAPD	7		**Recommend Auto Polarity Disable**
IINSEL	6		**IINSEL** 0_B Default value
RSHC	5:4		**Recommend Sample-Hold Current**
PFRV	3:2		**Pre-filter Recommend Value**
RBLL	1:0		**Recommend Base-line Limit**

Priority Control

Pri_cntl	Offset	Reset Value
Priority Control	**84_H**	**0_H**

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res												**HPP**				Res		**OFCE**						Res		**PP**					
												rw						rw								rw					

Field	Bits	Type	Description
Res	31:20		**Reserved** Not Applicable.
HPP	19:16	rw	**The Proportion of Normal and High Priority Packet** The transmit ratio between high/low queue will be 8xN:1, N is the value. 0000_B Unlimited 0001_B 8:1 0010_B 16:1 0011_B 24:1,....etc

Field	Bits	Type	Description
Res	15:14		**Reserved** Not Applicable.
OFCE	13:8	rw	**Auto-turn-off FC** Auto-turn-off FC when the programmed ports receive priority packet. *Note: [8] = port0, [9] = port 1 etc…* 0_B Disable
Res	7:6		**Reserved** Not Applicable.
PP	5:0	rw	**Port Priority** Force all the packet from the programmed port(s) are priority. *Note: [0] = port0, [1] = port 1 etc…* 0_B Normal 1_B high priority

VLAN Priority

VLAN_pri	Offset	Reset Value
VLAN Priority	88_H	400_H

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res																					VLANT			Res		VLANPC					
																					rw			rw		rw					

Field	Bits	Type	Description
Res	31:11		**Reserved** Not Applicable.
VLANT	10:8	rw	**VLAN High Priority Threshold** If the priority field in VLAN tag is not less than this threshold, then the packet is high priority. else it is low priority. 100_B Default value
Res	7:6		**Reserved** Not Applicable.
VLANPC	5:0		**Enable VLAN Priority Check** *Note: [0] = port0, [1] = port 1 etc…* 0_B Disable

TOS Enable

TOS_en	Offset	Reset Value
TOS Enable	$8C_H$	0_H

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res																										TOSP					
																										rw					

Field	Bits	Type	Description
Res	31:6		**Reserved** Not Applicable.
TOSP	5:0	rw	**Enable TCP/IP TOS Priority Check** *Note: [0] = port0, [1] = port 1 etc…* 0_B Disable 1_B Enable

TOS Map 0

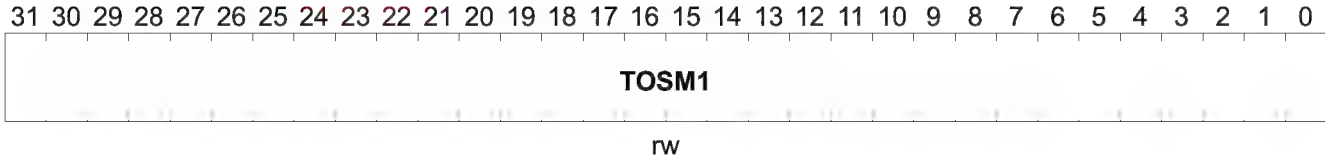
TOS_map0	Offset	Reset Value
TOS Map 0	90_H	0_H

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
TOSM0																															
rw																															

Field	Bits	Type	Description
TOSM0	31:0	rw	**TOS Bit Map 31:0** The TOS bit map totally has 64 bits. The bit define the incoming packet will be high or normal priority. The TOS value(0~63) of IP packets is used to select the relative bit map. 0_B Normal priority 1_B High priority

TOS Map 1

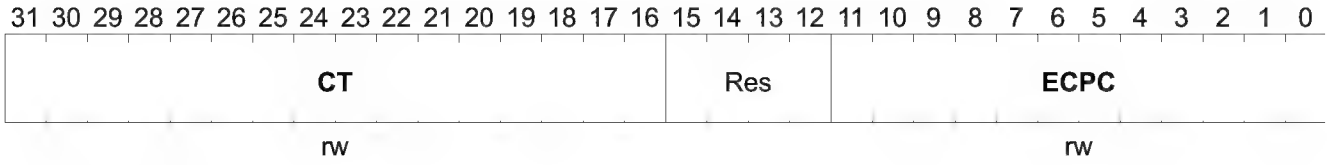
TOS_map1	Offset	Reset Value
TOS Map 1	94_H	0_H



Field	Bits	Type	Description
TOSM1	31:0	rw	**TOS Bit Map 64:32**

Custom Priority 1

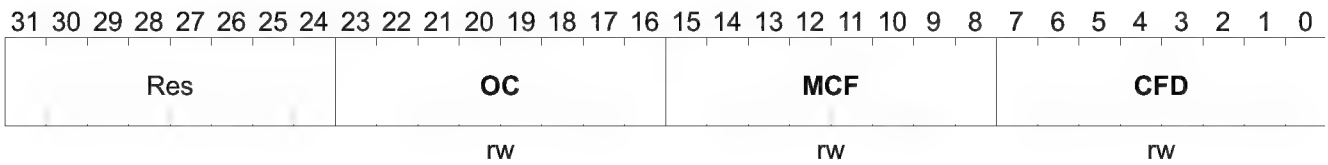
Custom_pri1 **Offset** **Reset Value**
Custom Priority 1 **98_H** **0_H**



Field	Bits	Type	Description
CT	31:16	rw	**Custom Type** This field defines the value of Customer Type that will be matched at the Type field of ether packets.
Res	15:12		**Reserved** Not Applicable.
ECPC	11:0	rw	**Enable Custom Packet Check** *Note: Enable custom packet check :bit [1:0] for port0, [3:2] for port1, [5:4] for port2, ...* 00_B Disable, default 01_B Treat as high priority 10_B Filtered 11_B Reserved

Custom Priority 2

Custom_pri2 **Offset** **Reset Value**
Custom Priority 2 **$9C_H$** **0_H**



Field	Bits	Type	Description
Res	31:24		**Reserved** Not Applicable.
OC	23:16	rw	**Offset Count from SA 7:0** This offset defines that the data will be extracted from the packets. The data will be compared with the Custom Field and Mask. The offset is counted from SA0 field of packet. If VLAN type found, it will add 4-byte automatically.
MCF	15:8		**Mask of Custom Field** The mask data for the Custom Field.
CFD	7:0		**Custom Field Define** This data defines the Custom Field that will be treated as higher priority or filtered.

PHY Control 4

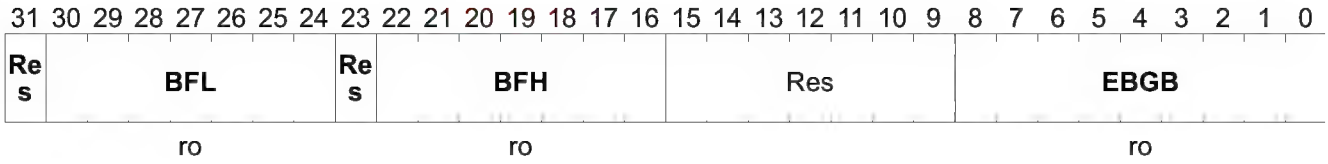
PHY_cntl4	Offset	Reset Value
PHY Control 4	$A0_H$	0_H

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res										RC25	V23	Res	P4CB	P4CBL		Res	P3CB	P3CBL		Res	P2CB	P2CBL		Res	P1CB	P1CBL		Res	P0CB	P0CBL	
										rw	rw		ro	ro			ro	ro			ro	ro			ro	ro			ro	ro	

Field	Bits	Type	Description
Res	31:22		**Reserved** Not Applicable.
RC25	21	rw	**Rom Code 25** 0_B 2.2 V (default) 1_B Fix the ROM code to 2.5 V
V23	20	rw	**Volt 23** 0_B 2.2 V (default) 1_B 10BaseT voltage 2.3 V
Res	19		**Reserved** Not Applicable.
P4CB	18	ro	**Port 4 Cable Broken**
P4CBL	17:16	ro	**Port 4 Cable Broken Length**
Res	15		**Reserved** Not Applicable.
P3CB	14	ro	**Port 3 Cable Broken**
P3CBL	13:12	ro	**Port 3 Cable Broken Length**
Res	11		**Reserved** Not Applicable.
P2CB	10	ro	**Port 2 Cable Broken**
P2CBL	9:8	ro	**Port 2 Cable Broken Length**
Res	7		**Reserved** Not Applicable.
P1CB	6	ro	**Port 1 Cable Broken**
P1CBL	5:4	ro	**Port 1 Cable Broken Length**
Res	3		**Reserved** Not Applicable.
P0CB	2	ro	**Port 0 Cable Broken**
P0CBL	1:0	ro	**Port 0 Cable Broken Length**

Empty Control

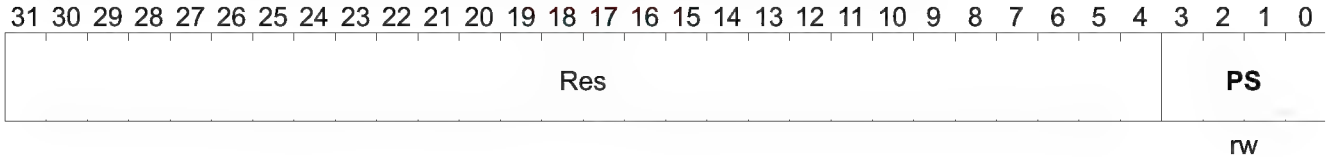
Empty_cnt	Offset	Reset Value
Empty Control	$A4_H$	0_H



Field	Bits	Type	Description
Res	31		**Reserved** Not Applicable.
BFL	30:24	ro	**Low-pri Out-queue Full status for CPU and Port[5:0]**
Res	23		**Reserved** Not Applicable.
BFH	22:16	ro	**The High-pri Out-queue Full status for CPU and Port[5:0]**
Res	15:9		**Reserved** Not Applicable.
EBGB	8:0	ro	**Empty Block in the Global Buffer**

Port Control Select

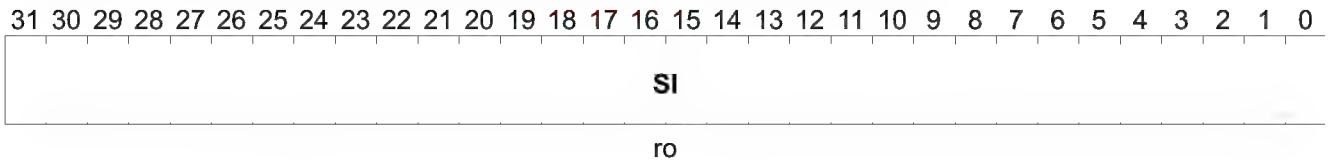
Port_cnt_sel	Offset	Reset Value
Port Control Select	$A8_H$	0_H



Field	Bits	Type	Description
Res	31:4		**Reserved** Not Applicable.
PS	3:0	rw	**Port Selected for the port_cnt**

Port Controller

Port_cnt	Offset	Reset Value
Port Controller	AC_H	0_H



Field	Bits	Type	Description
SI	31:0	ro	**Sel Info** If port_sel=0, [24:16] port0 high packet count [8:0] port0 low packet count If port_sel=1, [24:16] port1 high packet count [8:0] port1 low packet count If port_sel=2, [24:16] port2 high packet count [8:0] port2 low packet count If port_sel=3, [24:16] port3 high packet count [8:0] port3 low packet count If port_sel=4, [24:16] port4 high packet count [8:0] port4 low packet count If port_sel=5, [24:16] port5 high packet count [8:0] port5 low packet count If port_sel=6, [24:16] port6 high packet count [8:0] port6 low packet count If port_sel=7, [24:16] port7 high packet count [8:0] port7 low packet count If port_sel=9, [8:0] flow control status If port_sel=10, [24:16] testing [8:0] ever flow control port If port_sel=11, [24:16] no_pkt status [7:0] no_pkt_status If port_sel=12, [24:16] receive bandwidth control port, [8:0] transmit bandwidth control port

Int St

Note: All bits are "write 1 clear"

Int_st	Offset	Reset Value
Int St	$B0_H$	0_H

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res							CPUH	SDE	RDE	W1TE	W0TE	IP	PSC	Res	BCSS	MD	GET	CPUP	Res	P5QF	P4QF	P3QF	P2QF	P1QF	P0QF	LDF	HDF	RXLD	RXHD	SLD	SHD
							rw	rw	rw	rw	rw	rw	rw		rw	rw	rw	rw		rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw

Field	Bits	Type	Description
Res	31:25		**Reserved** Not Applicable.
CPUH	24	rw	**CPU Send Packets are Hold in Descriptor** Write one clear the status.
SDE	23		**Send Descriptor Error** Write one clear the status.
RDE	22		**Receive Descriptor Error** Write one clear the status.
W1TE	21		**Watchdog1 Timer Expired** Write one clear the status.
W0TE	20		**Watchdog0 Timer Expired** Write one clear the status.
IP	19		**Any Secured Port has Intruder Packets** Write one clear the status.
PSC	18		**Port Status Change** Any port change the link status (link-up to/from link-down). Write one clear the status.
Res	17		**Reserved** Not Applicable.
BCSS	16	rw	**Accumulated BC Count over BC_storm Setting** Write one clear the status.
MD	15		**Must Drop** All the buffer almost full. Write one clear the status.
GET	14		**Global empty-th** Write one clear the status.
CPUP	13		**CPU Port** Meet the CPU port pre-th & global empty-th. Write one clear the status.
Res	12		**Reserved** Not Applicable.

Field	Bits	Type	Description
P5QF	11	rw	**Meet the Port5 port-th & global empty-th** Write one clear the status.
P4QF	10		**Meet the Port4 port-th & global empty-th** Write one clear the status.
P3QF	9		**Meet the Port3 port-th & global empty-th** Write one clear the status.
P2QF	8		**Meet the Port2 port-th & global empty-th** Write one clear the status.
P1QF	7		**Meet the Port1 port-th & global empty-th** Write one clear the status.
P0QF	6		**Meet the Port0 port-th & global empty-th** Write one clear the status.
LDF	5		**Descriptor, "normal priority receive", are Full** Write one clear the status.
HDF	4		**Descriptor, "high priority receive", are Full** Write one clear the status.
RXLD	3		**DMA Receive one Normal Priority Packet to CPU** Write one clear the status.
RXHD	2		**DMA Receive one High Priority Packet to CPU** Write one clear the status.
SLD	1		**DMA Send one Normal Priority Packet to Switch** Write one clear the status.
SHD	0		**DMA Send one High Priority Packet to Switch** Write one clear the status.

Interrupt Mask

Note: 1: Mask the interrupt

Int_mask	Offset	Reset Value
Interrupt Mask	**$B4_H$**	**$1FDEFFF_H$**

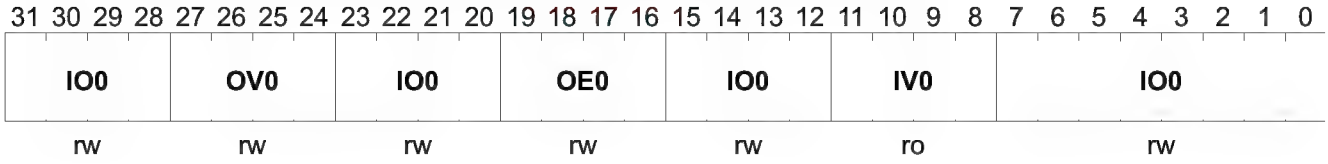
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res							CPUH	SDE	RDE	WITE	W0TE	MI	PSC	Res	BCS	MD	GQF	CPUQ	Res	P5QF	P4QF	P3QF	P2QF	P1QF	P0QF	LDF	HDF	RLD	RHD	SLD	SHD
							rw	rw	rw	rw	rw	rw	rw		rw	rw	rw	rw		rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw

Field	Bits	Type	Description
Res	31:25		**Reserved** Not Applicable.

Field	Bits	Type	Description
CPUH	24	rw	**Mask CPU Hold**
SDE	23		**Mask Send Description Error**
RDE	22		**Mask Receive Description Error**
W1TE	21		**Mask Wachdog1 Timer Expired**
W0TE	20		**Mask Wachdog0 Timer Expired**
MI	19		**Mask Intruder**
PSC	18		**Mask Port Status Change**
Res	17		**Reserved** Not Applicable.
BCS	16	rw	**Mask BC Storm**
MD	15		**Mast Drop**
GQF	14		**Mask Global Queue Full**
CPUQ	13		**Mask CPU Queue Full**
Res	12		**Reserved** Not Applicable.
P5QF	11	rw	**Mask Port5 Queue Full**
P4QF	10		**Mask Port4 Queue Full**
P3QF	9		**Mask Port3 Queue Full**
P2QF	8		**Mask Port2 Queue Full**
P1QF	7		**Mask Port1 Queue Full**
P0QF	6		**Mask Port0 Queue Full**
LDF	5		**Mask Low Descriptor Full**
HDF	4		**Mask High Descriptor Full**
RLD	3		**Mask Receive Low Done**
RHD	2		**Mask Receive High Done**
SLD	1		**Mask Send Low Done**
SHD	0		**Mask Send High Done**

GPIO Conf 0

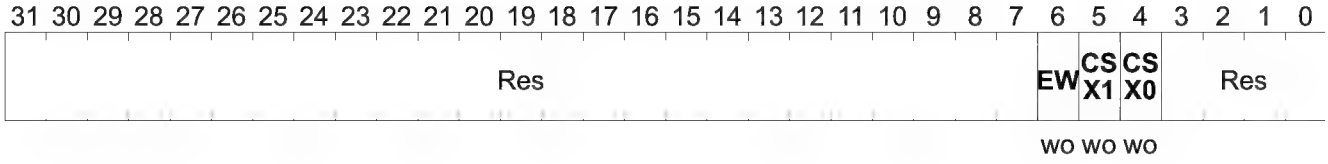
GPIO_conf0 **Offset** **Reset Value**
GPIO Conf 0 **$B8_H$** **FF_H**



Field	Bits	Type	Description
IO0	31:28	rw	**Reserved**
OV0	27:24	rw	**GPIO 3:0, Output Value if the Output Enable is one**
IO0	23:20	rw	**Reserved**
OE0	19:16	rw	**GPIO 3:0, Output Enable control** 0_B Input (default) 1_B Output Enable
IO0	15:12	rw	**Reserved**
IV0	11:8	ro	**GPIO 3:0, Input Value if in the Input Mode**
IO0	7:0	rw	**Reserved**

GPIO Conf 2

GPIO_conf2 **Offset** **Reset Value**
GPIO Conf 2 **BC_H** **0_H**

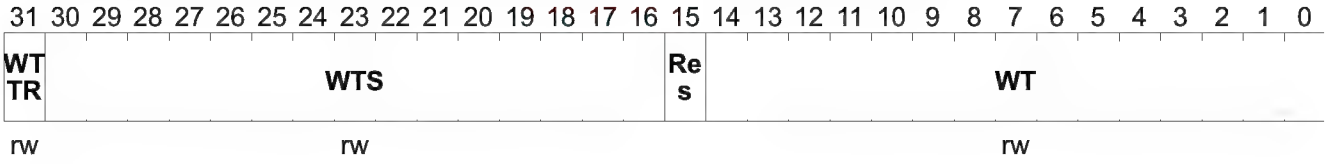


Field	Bits	Type	Description
Res	31:7		**Reserved** Not Applicable.
EW	6	wo	**Enable Wait State** 0_B Disable wait state for external IO control CSX0 and CSX1(default) 1_B Enable the wait state pin GPIO[0] for external IO control CSX0 and CSX1
CSX1	5	wo	**Enable CSX1in GPIO 3** 0_B Disable the CSX1 function(default) 1_B Enable the CSX1 function

Field	Bits	Type	Description
CSX0	4	wo	**Enable CSX0, INTX0 Interface in GPIO 1:2** 0_B Disable the CSX0/INTX0 function.(default) 1_B Enable the CSX0 and INTX0 function
Res	3:0		**Reserved** Not Applicable.

Watchdog 0

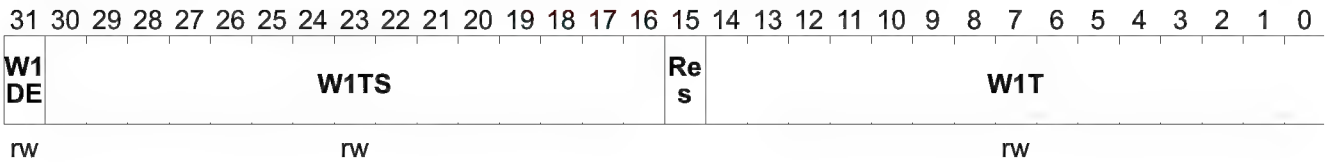
Wdog_0	Offset	Reset Value
Watchdog 0	$C0_H$	$7FFF0000_H$



Field	Bits	Type	Description
WTTR	31	rw	**Watchdog Timer Trigger Reset** 0_B Disable(default) 1_B Reset the whole chip if watchdog timer is expired
WTS	30:16	rw	**Watchdog Timer Set** The time out setting of timer, if timer set is equal to timer, then it means that the timer is expired. Maximum 32767.
Res	15		**Reserved** Not Applicable.
WT	14:0	rw	**Watchdog Timer** Count up timer, mask-able, read clear, unit 10 ms. If reach timer set mean time up and keep the counter until read-clear by software, maximum 327 s.

Watchdog 1

Wdog_1 Watchdog 1	Offset $C4_H$	Reset Value $7FFF0000_H$



Field	Bits	Type	Description
W1DE	31	rw	**Watchdog Timer Stop CPU Port Receiving** No issue flow control in ports. Auto-recover when the timer is cleaned. 0_B Disable(default) 1_B Force all to CPU packets drop if timer is expired, and no issue flow control in ports. Auto-recover when the timer is cleaned
W1TS	30:16	rw	**Watchdog 1 Timer Set** The time out setting of the timer, if timer set is equal to timer, then it means that the timer is expired. Maximum 32767.
Res	15		**Reserved** Not Applicable.
W1T	14:0	rw	**Watchdog 1 Timer** Count up timer, mask-able, read clear, unit 10 ms. If reach timer set mean time up and keep the counter until read-clear by software, maximum 327 s.

Swap In

Swap_in	Offset	Reset Value
Swap In	$C8_H$	0_H

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SDI0								SDI1								SDI2								SDI3							
rw								rw								rw								rw							

Field	Bits	Type	Description
SDI0	31:24	rw	**Swap_in 31:24 = Swap_out 7:0**
SDI1	23:16		**Swap_in 23:16 = Swap_out 15:8**
SDI2	15:8		**Swap_in 15:8 = Swap_out 15:8**
SDI3	7:0		**Swap_in 7:0 = Swap_out 31:24**

Swap Out

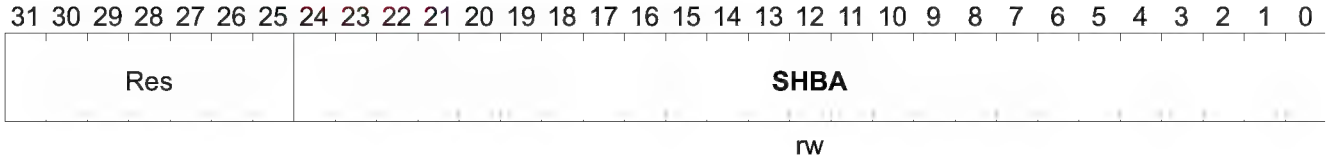
Swap_out	Offset	Reset Value
Swap Out	CC_H	0_H

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SDO0								SDO1								SDO2								SDO3							
ro								ro								ro								ro							

Field	Bits	Type	Description
SDO0	31:24	ro	**Swap_out 31:24 = Swap_in 7:0**
SDO1	23:16		**Swap_out 23:16 = Swap_in 15:8**
SDO2	15:8		**Swap_out 15:8 = Swap_in 23:16**
SDO3	7:0		**Swap_out 7:0 = Swap_in 31:24**

Send High Base Address

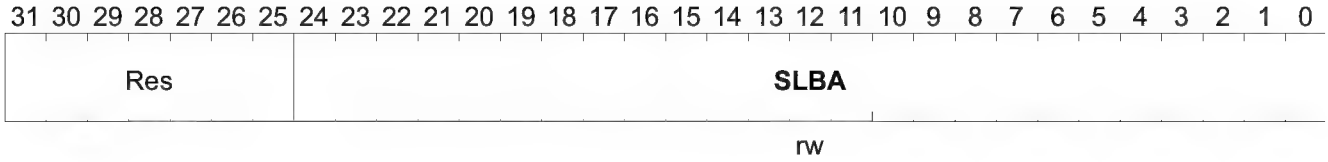
send_Hbaddr	Offset	Reset Value
Send High Base Address	$D0_H$	0_H



Field	Bits	Type	Description
Res	31:25		**Reserved** Not Applicable.
SHBA	24:0	rw	**The Descriptor Base Address of CPU_to_SW (high priority)**

Send Low Base Address

send_Lbaddr	Offset	Reset Value
Send Low Base Address	**$D4_H$**	**0_H**



Field	Bits	Type	Description
Res	31:25		**Reserved** Not Applicable.
SLBA	24:0	rw	**The Descriptor Base Address of CPU_to_SW (normal priority)**

Receive High Base Address

rec_Hbaddr	Offset	Reset Value
Receive High Base Address	$D8_H$	0_H

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res							RHBA																								
							rw																								

Field	Bits	Type	Description
Res	31:25		**Reserved** Not Applicable.
RHBA	24:0	rw	**The Descriptor Base Address of SW_to_CPU (high priority)**

Receive Low Base Address

rec_Lbaddr	Offset	Reset Value
Receive Low Base Address	DC_H	0_H

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res							RLBA																								
							rw																								

Field	Bits	Type	Description
Res	31:25		**Reserved** Not Applicable.
RLBA	24:0	rw	**The Descriptor Base Address of SW_to_CPU (normal priority)**

Send High Working Address

send_Hwaddr	Offset	Reset Value
Send High Working Address	$E0_H$	0_H

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res							SHWA																								
							ro																								

Field	Bits	Type	Description
Res	31:25		**Reserved** Not Applicable.
SHWA	24:0	ro	**The Descriptor WORKING Address of CPU_to_SW (high priority)**

Send Low Working Address

send_Lwaddr	Offset	Reset Value
Send Low Working Address	$E4_H$	0_H

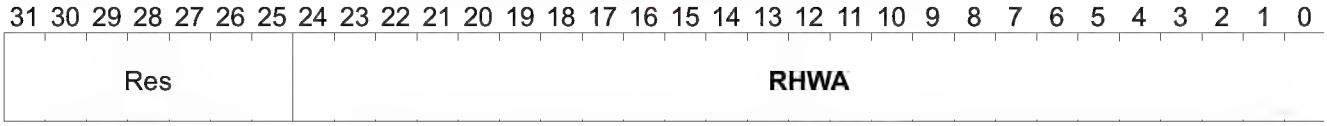
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res							SLWA																								
							ro																								

Field	Bits	Type	Description
Res	31:25		**Reserved** Not Applicable.
SLWA	24:0	ro	**The Descriptor WORKING Address of CPU_to_SW (normal priority)**

Receive High Working Address

rec_Hwaddr — **Offset** $E8_H$ — **Reset Value** 0_H

Receive High Working Address

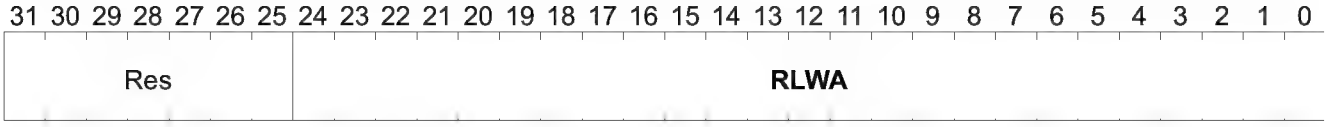


Field	Bits	Type	Description
Res	31:25		**Reserved** Not Applicable.
RHWA	24:0	ro	**The Descriptor WORKING Address of SW_to_CPU (high priority)**

Receive Low Working Address

rec_Lwaddr — **Offset** EC_H — **Reset Value** 0_H

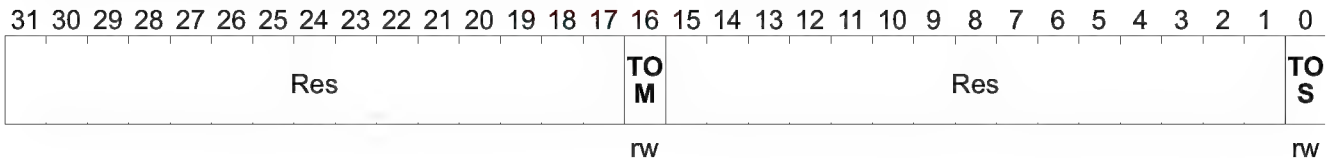
Receive Low Working Address



Field	Bits	Type	Description
Res	31:25		**Reserved** Not Applicable.
RLWA	24:0	ro	**The Descriptor WORKING Address of SW_to_CPU (normal priority)**

Timer Interrupt

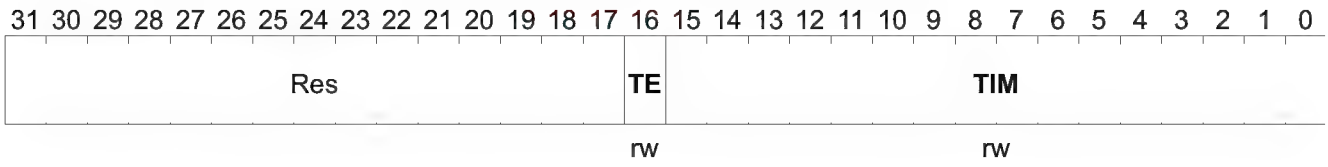
Timer_int	Offset	Reset Value
Timer Interrupt	$F0_H$	10000_H



Field	Bits	Type	Description
Res	31:17		**Reserved** Not Applicable.
TOM	16	rw	**Time Out Mask** 1_D Mask the time out interrupt(default) 0_D Enable the time out interrupt
Res	15:1		**Reserved** Not Applicable.
TOS	0	rw	**Time Out Status** Write 1 clear the time out status. Show the time out status on read. The status is down count to zero on **Timer** register.

Timer

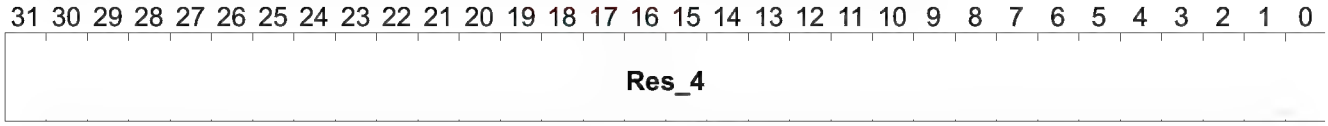
Timer	Offset	Reset Value
Timer	$F4_H$	$FFFF_H$



Field	Bits	Type	Description
Res	31:17		**Reserved** Not Applicable
TE	16	rw	**Timer Enable** 0_B Disable the timer count down(default) 1_B Enable the timer count down
TIM	15:0		**Timer** Unit 640 ns, auto-reload. Set the time out value on write. Read will return the current timer value. $FFFF_H$ Default value

Reserved 4

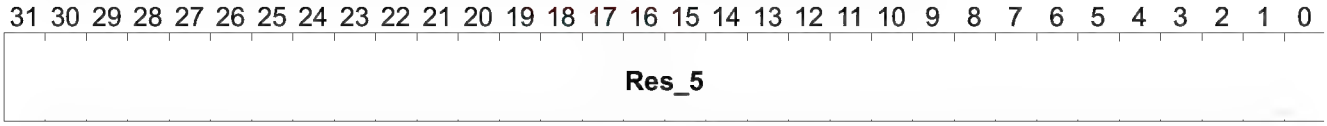
Res_4	Offset	Reset Value
Reserved 4	$F8_H$	0_H



Field	Bits	Type	Description
Res_4	31:0		**Reserved** Not Applicable.

Reserved 5

Res_5	Offset	Reset Value
Reserved 5	FC_H	0_H

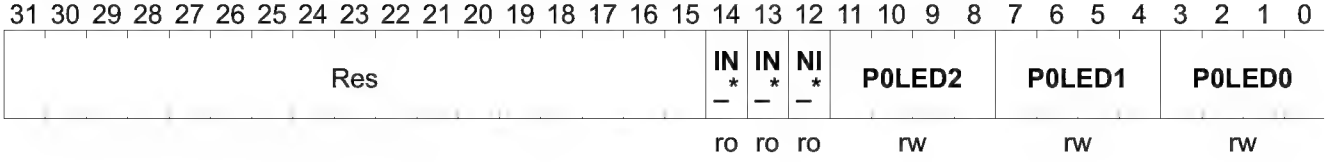


Field	Bits	Type	Description
Res_5	31:0		**Reserved** Not Applicable.

Port 0 LED

Note: Port0 LED[2:0] pin (164,165,166) configuration register.

port0_LED	Offset	Reset Value
Port 0 LED	100_H	$A59_H$



Field	Bits	Type	Description
Res	31:15		**Reserved** Not Applicable.
IN_P0LED2	14	ro	**Input in Port 0 LED2** Input value at pin Port 0 LED2 when it is configured to GPIO_in mode
IN_P0LED1	13	ro	**Input in Port 0 LED1** Input value at pin Port 0 LED1 when it is configured to GPIO_in mode
NI_P0LED0	12	ro	**Input in Port 0 LED0** Input value at pin Port 0 LED0 when it is configured to GPIO_in mode

Field	Bits	Type	Description
P0LED2	11:8	rw	**Port 0 LED2 State** 0000_B GPIO_in. 0001_B GPIO_output_flash. 0010_B GPIO_output_1 0011_B GPIO_output_0. 0100_B Link (steady). 0101_B Speed (steady) 0110_B Duplex (steady). 0111_B Activity (flash). 1000_B Collision (flash) 1001_B Link + activity. 1010_B Default value, duplex/col 1011_B 10M_link + activity 1100_B 100M_link + activity. 1101_B Reserved. 1110_B Reserved. 1111_B Reserved.
P0LED1	7:4		**Port 0 LED1 State** Refer to the definition in **P0LED2** except the default value. 0101_B Default value, speed
P0LED0	3:0		**Port 0 LED0 State** Refer to the definition in **P0LED2** except the default value. 1001_B Default value, Link/activity

Port 1 LED

Note: Port1 LED[2:0] pin (161,162,163) configuration register.

port1_LED	Offset	Reset Value
Port 1 LED	104_H	$A59_H$

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res																	IN_P1LED2	IN_P1LED1	IN_P1LED0	P1LED2				P1LED1				P1LED0				
																	ro	ro	ro	rw				rw				rw				

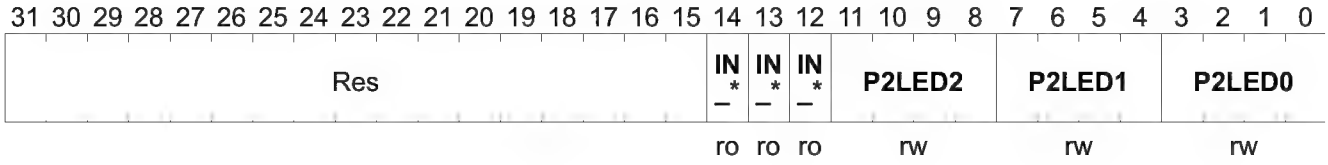
Field	Bits	Type	Description
Res	31:15		**Reserved** Not Applicable.
IN_P1LED2	14	ro	**Input in Port 1 LED2** Input value at pin Port 1 LED2 when it is configured to GPIO_in mode
IN_P1LED1	13	ro	**Input in Port 1 LED1** Input value at pin Port 1 LED1 when it is configured to GPIO_in mode
IN_P1LED0	12	ro	**Input in Port 1 LED0** Input value at pin Port 1 LED0 when it is configured to GPIO_in mode

Field	Bits	Type	Description
P1LED2	11:8	rw	**Port 1 LED2 State** Refer to the definition in **P0LED2** except the default value. 1010_B Default value, duplex/col
P1LED1	7:4		**Port 1 LED1 State** Refer to the definition in **P0LED2** except the default value. 0101_B Default value, speed
P1LED0	3:0		**Port 1 LED0 State** Refer to the definition in **P0LED2** except the default value. 1001_B Default value, link/activity

Port 2 LED

Note: Port2 LED[2:0] pin (147,158,160) configuration register.

port2_LED	Offset	Reset Value
Port 2 LED	108_H	$A59_H$

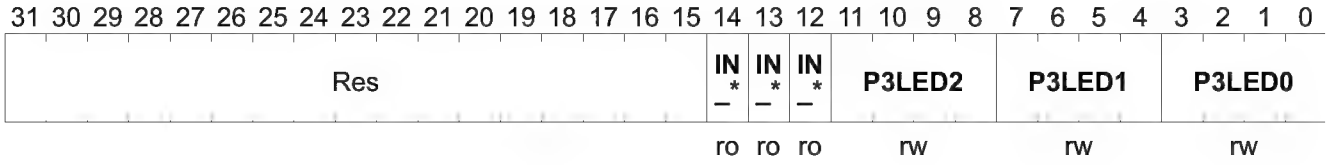


Field	Bits	Type	Description
Res	31:15		**Reserved** Not Applicable.
IN_P2LED2	14	ro	**Input in Port 2 LED2** Input value at pin Port 2 LED2 when it is configured to GPIO_in mode
IN_P2LED1	13	ro	**Input in Port 2 LED1** Input value at pin Port 2 LED1 when it is configured to GPIO_in mode
IN_P2LED0	12	ro	**Input in Port 2 LED0** Input value at pin Port 2 LED0 when it is configured to GPIO_in mode
P2LED2	11:8	rw	**Port 2 LED2 State** Refer to the definition in **P0LED2** except the default value. 1010_B Default value, duplex/col
P2LED1	7:4		**Port 2 LED1 State** Refer to the definition in **P0LED2** except the default value. 0101_B Default value, speed
P2LED0	3:0		**Port 2 LED0 State** Refer to the definition in **P0LED2** except the default value. 1001_B Default value, link/activity

port3_LED

Note: Port3 LED[2:0] pin (144,145,146) configuration register.

port3_LED	Offset	Reset Value
Port 3 LED	$10C_H$	$A59_H$

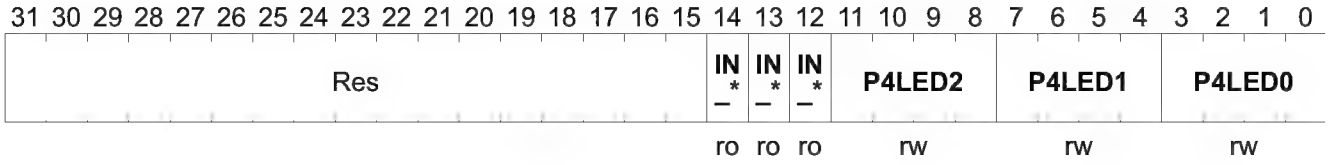


Field	Bits	Type	Description
Res	31:15		**Reserved** Not Applicable.
IN_P3LED2	14	ro	**Input in Port 3 LED2** Input value at pin Port 3 LED2 when it is configured to GPIO_in mode
IN_P3LED1	13	ro	**Input in Port 3 LED1** Input value at pin Port 3 LED1 when it is configured to GPIO_in mode
IN_P3LED0	12	ro	**Input in Port 3 LED0** Input value at pin Port 3 LED0 when it is configured to GPIO_in mode
P3LED2	11:8	rw	**Port 3 LED2 State** Refer to the definition in **P0LED2** except the default value. 1010_B Default value, duplex/col
P3LED1	7:4		**Port 3 LED1 State** Refer to the definition in **P0LED2** except the default value. 0101_B Default value, speed
P3LED0	3:0		**Port 3 LED0 State** Refer to the definition in **P0LED2** except the default value. 1001_B Default value, link/activity

port4_LED

Note: Port4 LED[2:0] pin (141,142,143) configuration register.

port4_LED	Offset	Reset Value
Port 4 LED	110_H	$A59_H$



Field	Bits	Type	Description
Res	31:15		**Reserved** Not Applicable.
IN_P4LED2	14	ro	**Input in Port 4 LED2** Input value at pin Port 4 LED2 when it is configured to GPIO_in mode
IN_P4LED1	13	ro	**Input in Port 4 LED1** Input value at pin Port 4 LED1 when it is configured to GPIO_in mode
IN_P4LED0	12	ro	**Input in Port 4 LED0** Input value at pin Port 4 LED0 when it is configured to GPIO_in mode
P4LED2	11:8	rw	**Port 4 LED2 State** Refer to the definition in **P0LED2** except the default value. 1010_B Default value, duplex/col
P4LED1	7:4		**Port 4 LED1 State** Refer to the definition in **P0LED2** except the default value. 0101_B Default value, speed
P4LED0	3:0		**Port 4 LED0 State** Refer to the definition in **P0LED2** except the default value. 1001_B Default value, link/activity

7 UART

The UART description covers:

- Feature list (**Chapter 7.1**)
- Functional description (**Chapter 7.2**)
- External Interface; described in the dedicated chapter of the different interfaces
- Registers (**Chapter 7.3**)

7.1 Feature List

The UART offers the following features:

- Separate 16 x 8 transmit and 16 x 12 receive FIFO to reduce CPU interrupts
- Programmable baud rate generator
- Standard asynchronous communication bits(start, stop and parity). These are added prior to transmission and removed on reception.
- Fully-programmable serial interface characteristic:
  - Data can be 5, 6, 7 or 8 bits
  - Even, odd, stick or no-parity bit generation and detection
  - 1 or 2 stop bit generation
  - Baud rate generation
- Programmable hardware flow control

7.2 Functional Description

The UART performs:

- Serial-to-parallel conversion on data received from a peripheral device
- Parallel-to-serial conversion on data transmitted to the peripheral device.

The CPU reads and writes data and control/status information through the AMBA APB interface. The transmit and receive paths are buffered with internal FIFO memories enabling up to 16-bytes to be stored independently in both transmit and receive modes.

The UART:

- Includes a programmable baud rate generator that generates a common transmit and receive internal clock from the UART internal reference clock input, UARTCLK = 62.5 MHz
- Offers similar functionality to industry-standard 16C550 UART device
- Supports baud rates up to 460.8 Kbits/s, subject to UARTCLK reference clock frequency.
- UART operations are controlled by the line control register(**UARTLCR_H**)
- The baud rate values are controlled by the **UARTLCR_M** and **UARTLCR_L** registers
- Can generate individually maskable interrupts from the receive, transmit, modem status and error conditions
- Supports modem status input signals CTS, DCD, DSR and RI
- Supports modem output control lines RTS and DTR
- Uses the nUARTCTS input and nUARTRTS output to automatically control the serial data flow.

Figure 13 shows a block diagram of UART.

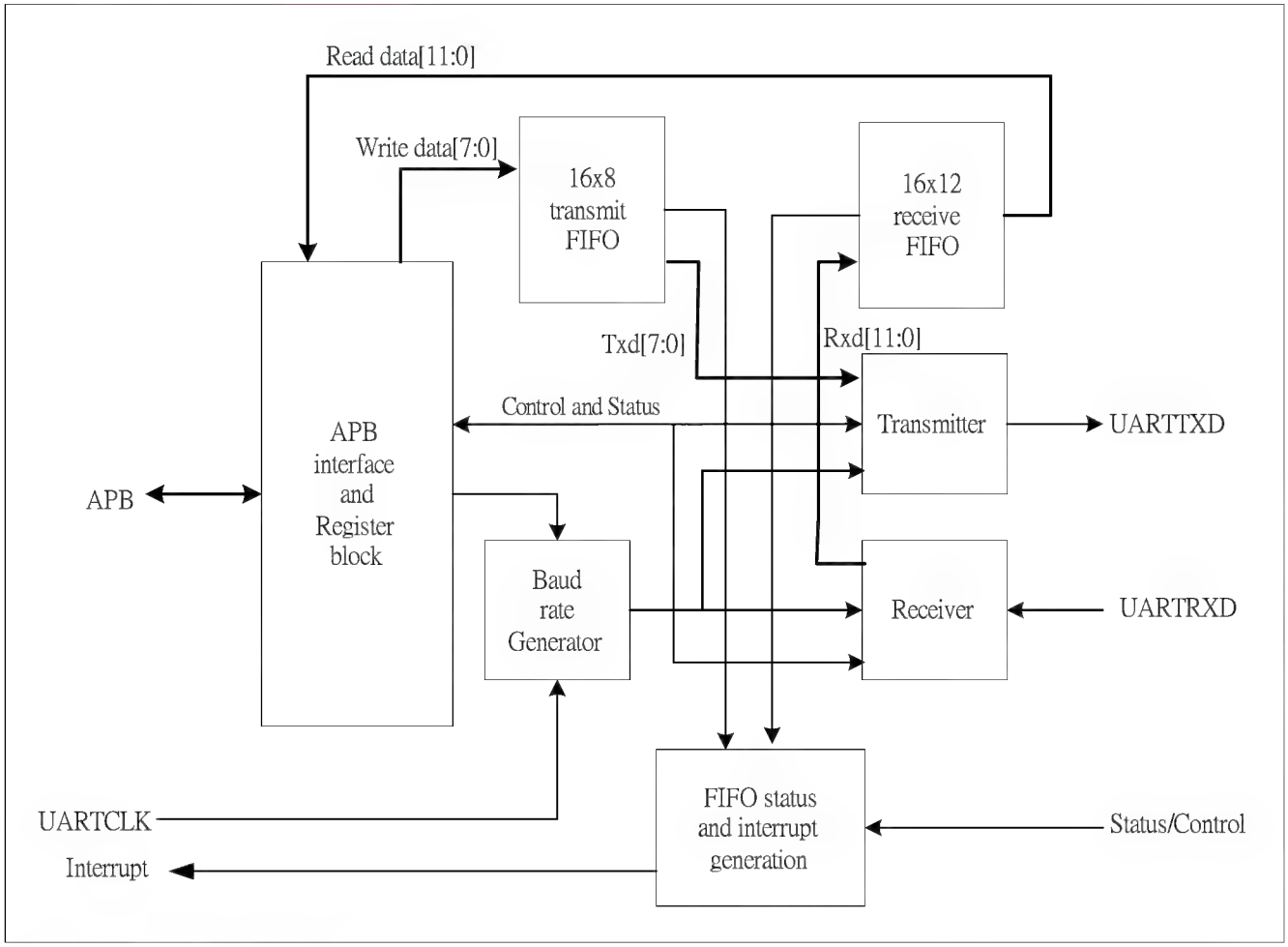


Figure 13 UART block diagram

7.2.1 AMBA APB Interface

The AMBA APB interface generates read and write decodes for accesses to status/control registers and transmit/receive FIFO memories.

7.2.2 Register Block

The register block stores data written to, or to be read across the AMBA APB interface.

7.2.3 Baud Rate Generator

The baud rate generator contains free-running counters that generate the internal x16 clocks, Baud16. Baud16 provides timing information for UART transmit and receive control. Baud16 is a stream of pulses with a width of one UARTCLK clock period and a frequency of 16 times the baud rate.

7.2.4 Transmit FIFO

The transmit FIFO is an 8-bit wide, 16 location deep, FIFO memory buffer. CPU data written across the APB interface is stored in the FIFO until read out by the transmit logic. You can disable the transmit FIFO to act like a one-bye holding register.

7.2.5 Receive FIFO

The receive FIFO is a 12-bit wide, 16 location deep, FIFO memory buffer. Received data and corresponding error bits, are stored in the receive FIFO by the receive logic until read out by the CPU across the APB interface. The receive FIFO can be disabled to act like a one-byte holding register.

7.2.6 Transmit Logic

The transmit logic performs parallel-to-serial conversion on the data read from the transmit FIFO. Control logic outputs the serial bit stream beginning with a start bit, data bits with the LSB first, followed by the parity bit, and then the stop bits according to the programmed configuration in control registers.

7.2.7 Receive Logic

The receive logic performs serial-to-parallel conversion on the received bit stream after a valid start pulse has been detected. Overrun, parity, frame error checking, and line break detection are also performed, and their status accompanies the data that is written to the receive FIFO.

7.3 UART Registers

There are two UART port, one base address is 0x1260 0000 and the other is 0x1280 0000.

Table 36 Registers Address Space

Module	Base Address	End Address	Note
UART	$1260\ 0000_H$	$1F_H$	–

Table 37 Registers Overview

Register Short Name	Register Long Name	Offset Address	Page Number
UART_D	UART Data	00_H	172
UARTRRS_ECR	UART Receive Status Register/Error Clear	04_H	173
UARTLCR_H	UART Line Control Register, High Byte	08_H	173
UARTLCR_M	UART Line Control Register, Middle Byte	$0C_H$	174
UARTLCR_L	UART Line control Register, Low Byte	10_H	175
UARTCR	UART Control	14_H	175
UARTFR	UART Flag	18_H	177
UARTIIR_UARTICR	UART Interrupt Identification/Clear	$1C_H$	178

The register is addressed wordwise.

Table 38 Registers Access Types

Mode	Symbol	Description Hardware (HW)	Description Software (SW)
Basic Access Types			
read/write	rw	Register is used as input for the HW	Register is read and writable by SW
read/write virtual	rwv	Physically, there is no new register in the generated register file. The real readable and writable register resides in the attached hardware.	Register is read and writable by SW (same as rw type register)
read	r	Register is written by HW (register between input and output -> one cycle delay)	Value written by SW is ignored by HW; that is, SW may write any value to this field without affecting HW behavior
read only	ro	Same as r type register	Same as r type register
read virtual	rv	Physically, there is no new register in the generated register file. The real readable register resides in the attached hardware.	Value written by SW is ignored by HW; that is, SW may write any value to this field without affecting HW behavior (same as r type register)
write	w	Register is written by software and affects hardware behavior with every write by software.	Register is writable by SW. When read, the register does not return the value that has been written previously, but some constant value instead.
write virtual	wv	Physically, there is no new register in the generated register file. The real writable register resides in the attached hardware.	Register is writable by SW (same as w type register)
read/write hardware affected	rwh	Register can be modified by hardware and software at the same time. A priority scheme decides, how the value changes with simultaneous writes by hardware and software.	Register can be modified by HW and SW, but the priority SW versus HW has to be specified. SW can read the register.

Table 39 Registers Clock Domains

Clock Short Name	Description
–	–

7.3.1 UART Registers Description

UART Data

UART_D	Offset	Reset Value
UART Data	00_H	0_H

7	6	5	4	3	2	1	0
UDR							
rw							

Field	Bits	Type	Description
UDR	7:0	rw	**Data Register** Receive (read) data character Transmit (write) data character

UART Receive Status Register/Error Clear

UARTRRS_ECR	Offset	Reset Value
UART Receive Status Register/Error Clear	04_H	0_H

7	6	5	4	3	2	1	0
RSR	Res			**OE**	**BE**	**PE**	**FE**
w	r			r	r	r	r

Field	Bits	Type	Description
RSR	7	w	**RSR** A write to this register clears the framing, parity, break and overrun errors. The data value is not important.
Res	6:4	r	**Reserved** Not applicable.
OE	3		**Overrun Error** This bit is set to 1 if data is received and the FIFO is already full.
BE	2		**Break Error** This bit is set to 1 if a break condition was detected, indicating that the received data input was held LOW for longer than a full-word transmission time.
PE	1		**Parity Error** When this bit is set to 1, it indicates that the parity of received data character does pot match the parity selected in UARTLCR_H (bit 2)
FE	0		**Framing Error** When this bit is set to 1, it indicates that the received character did not have a valid stop bit.

UART Line Control Register, High Byte

UARTLCR_H	Offset	Reset Value
UART Line Control Register, High Byte	08_H	0_H

7	6	5	4	3	2	1	0
Res	**WLEN**		**FEN**	**STP2**	**EPS**	**PEN**	**BRK**
	rw		rw	rw	rw	rw	rw

Field	Bits	Type	Description
Res	7		**Reserved** Not applicable

Field	Bits	Type	Description
WLEN	6:5	rw	**Word Length [1:0]** The select bits indicate the number of data bits transmitted or received in a frame as follows:11 = 8 bits10 = 7 bits01 = 6 bits00 = 5 bits 11_B 8 bits 10_B 7 bits 01_B 6 bits 00_B 5 bits
FEN	4		**Enable FIFOs** If this bit is set to 1,transmit and receive FIFO buffers are enabled (FIFO mode). When cleared to 0 the FIFOs are disabled (character mode) that is, the FIFOs become 1 byte-deep holding registers.
STP2	3		**Two Stop Bits Select** If this bit is set to 1, two stop bits are transmitted at the end of the frame. The receive logic does not check for two stop bits being received.
EPS	2		**Even Parity Select** If this bit is set to 1, even parity generation and checking is performed during transmission and reception, which checks for an even number of 1s in data and parity bits. When cleared to 0 then odd parity is performed which checks for an odd number of 1s.this bit has no effect when parity is disabled by parity enable being cleared to 0.
PEN	1		**Parity Enable** If this bit is set to 1, parity checking and generation is enabled, else parity is disabled and no parity bit passed to the data frame.
BRK	0		**Send Break** If this bit is set to 1, a low-level is continually output on the UARTTXD output, after completing transmission of the current character. This bit must be asserted for at least one complete frame transmission time in order to generate a break condition. The transmit FIFO contents remain unaffected during a break condition.For normal use, this bit must be cleared to 0.

UART Line Control Register, Middle Byte

UARTLCR_M	Offset	Reset Value
UART Line Control Register, Middle Byte	$0C_H$	0_H

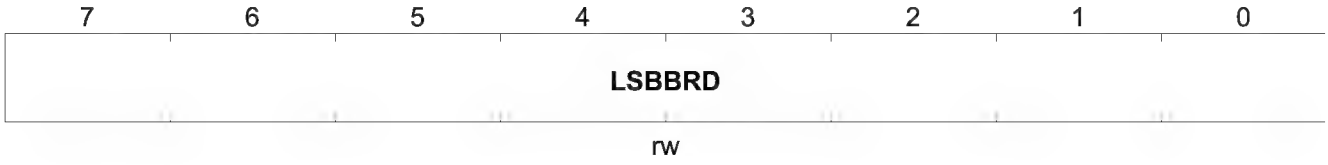
7	6	5	4	3	2	1	0
MSBBRD							
rw							

Field	Bits	Type	Description
MSBBRD	7:0	rw	**Most Significant Byte of Baud Rate Divisor** These bits are cleared to 0 on reset.

UART Line Control Register, Low Byte

Note: The baud rate divisor is calculated as follow:
*Baud rat divisor BAUDDIV = (FUARTCLK/(16*Baud rate))-1*
Where FUARTCLK is the UART reference clock frequency
The below table show some typical bit rates and their corresponding divisor, given a UART clock frequency of 62.5 MHz. A divisor value of zero is illegal, and so no transmission or reception will occur.

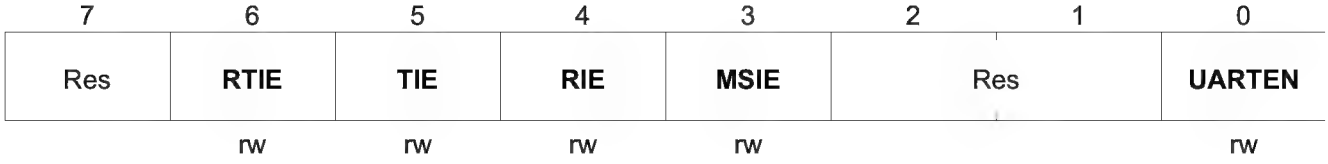
UARTLCR_L	Offset	Reset Value
UART Line control Register, Low Byte	10_H	0_H



Field	Bits	Type	Description
LSBBRD	7:0	rw	**Least Significant Byte of Baud Rate Divisor** These bits are cleared to 0 on reset.

UART Control

UARTCR	Offset	Reset Value
UART Control	14_H	0_H



Field	Bits	Type	Description
Res	7		**Reserved** Not applicable.
RTIE	6	rw	**Receive Timeout Interrupt Enable** If this bit is set to 1, the receive timeout interrupt is enabled. The receive timeout interrupt is asserted when the receive FIFO is not empty and no further data is received over a 32-bit period. The receive timeout interrupt is cleared when the FIFO becomes empty through reading all the data.

Field	Bits	Type	Description
TIE	5	rw	**Transmit Interrupt Enable** If this bit is set to 1, the transmit interrupt is enabled. The transmit interrupt changes state when one of the following events occurs: 1.if the FIFOs are enabled and the transmit FIFO is at least half empty, then the transmit interrupt is asserted HIGH. It is cleared by filling the transmit FIFO to more than half full. 2.if the FIFOs are disabled and there is no data preset in the transmitters single location, the transmit FIFO is asserted HIGH. It is cleared by performing a single write to the transmitter FIFO.
RIE	4	rw	**Receive Interrupt Enable** If this bit is set to 1, the receive interrupt is enabled. The receive interrupt changes state when one of the following events occurs: 1.if the FIFOs are enabled and the receive FIFO is half or more full, then the receive interrupt is asserted HIGH. It is cleared by reading data from the receive FIFO until it becomes less than half full. 2.if the FIFOs are disabled and data is received thereby filling the location, the receive interrupt is asserted HIGH. The receive interrupt is cleared by performing a single read to the receive FIFO.
MSIE	3	rw	**Modem Status Interrupt Enable** If this bit is set to 1, the modem interrupt is enabled. The modem status interrupt is asserted if any of the modem status lines (CTS,DCD,DSR) change. Modem status changes when one of the following events occurs: (1) 0 → 1 (2) 1 → 0
Res	2:1		**Reserved** Not applicable
UARTEN	0	rw	**UART Enable** If this bit set to 1, the UART is enabled.

UART Flag

UARTFR UART Flag	Offset 18_H	Reset Value 0_H

7	6	5	4	3	2	1	0
TXFE	**RXFF**	**TXFF**	**RXFE**	**BUSY**	**DCD**	**DSR**	**CTS**
ro	ro	ro	ro	ro	ro	ro	ro

Field	Bits	Type	Description
TXFE	7	ro	**Transmit FIFO Empty** The meaning of this bit depends on the state of the FEN bit in the UARTLCR_H register If the FIFO is disabled, this bit is set when the transmit holding register is empty. If the FIFO is enabled, the TXFE bit is set when the transmit FIFO is empty.
RXFF	6		**Receive FIFO Full** The meaning of this bit depends on the state of the FEN bit in the UARTLCR_H register. If the FIFO is disabled, this bit is set when the receive holding register is full. If the FIFO is enabled, the RXFF bit is set when the receive FIFO is full.
TXFF	5		**Transmit FIFO Full** The meaning of this bit depends on the state of the FEN bit in the UARTLCR_H register. If the FIFO is disabled, this bit is set when the transmit holding register is full. If the FIFO is enabled, the RXFE bit is set when the transmit FIFO is full.
RXFE	4		**Receive FIFO Empty** The meaning of this bit depends on the state of the FEN bit in the UARTLCR_H register. If the FIFO is disabled, this bits is set when the receive holding register is empty. If the FIFO is enabled, the RXFE bit is set when the receive FIFO is empty.
BUSY	3		**UART Busy** If this bit is set to 1, the UART is busy transmitting data. This bit remains set until the complete byte, including all the stop bits, has been sent from the shift register. This bit is set as soon as the transmit FIFO becomes non-empty.
DCD	2		**Data Carrier Detect** This bit is the complement of the UART data carrier detect (nUARTDCD) modem status input. That is , the bit is 1 when the modem status input is 0.
DSR	1		**Data Set Ready** This bit is the complement of the UART data set ready (nUARTDSR) modem status input. That is , the bit is 1 when the modem status input is 0.
CTS	0		**Clear to Send** This bit is the complement of the UART clear to send (nUARTCTS) modem status input. That is , the bit is 1 when the modem status input is 0.

UART Interrupt Identification/Clear

UARTIIR_UARTICR	Offset	Reset Value
UART Interrupt Identification/Clear	$1C_H$	0_H

7	6	5	4	3	2	1	0
UICR	Res			**RTIS**	**TIS**	**RIS**	**MIS**
w				r	r	r	r

Field	Bits	Type	Description
UICR	7	w	**Interrupt Clear** A write to this register clears the modem status interrupt, regardless of the value written.
Res	6:4		**Reserved** Not applicable.
RTIS	3	r	**Receive Timout Interrupt** This bit is set to 1 if the UARTRTINTR receive timeout interrupt is asserted.
TIS	2		**Transmit Interrupt** This bit is set to 1 if the UARTRTINTR transmit interrupt is asserted.
RIS	1		**Receive Interrupt** This bit is set to 1 if the UARTRTINTR receive interrupt is asserted.
MIS	0		**Modem Interrupt Status** This bit is set to 1 if the UARTRTINTR modem status interrupt is asserted.

8 USB 1.1 Host Controller

The USB 1.1 host controller provides a USB host solution that can communicate with full speed and low speed devices.

The USB 1.1 host controller covers:

- Feature list (**Chapter 8.1**)
- Functional description (**Chapter 8.2**)
- DMA operation **Chapter 8.3**
- Registers (**Chapter 8.3.1.1** and **Chapter 8.3.1.2**)

8.1 Feature List

- 32 bit high performance AMBA AHB bus interface
- Little/Big endian byte ordering
- 32-bit Tx/Rx buffer management architecture
- Supports full speed (12Mbps) and low speed (1.5Mbps)
- Supports embedded DPLL to operate from 48 MHz crystal or oscillator
- Supports automatic generation of SOF and CRC5/16
- Supports DMA mode for USB Control, Interrupt and Bulk packets
- Supports descriptor chain architecture for effective packet scheduling
- Support two device ports

8.2 USB 1.1 Function Description

8.2.1 Block Diagram

The following block diagram describes the functional blocks of the Infineon USB 1.1 Host controller.

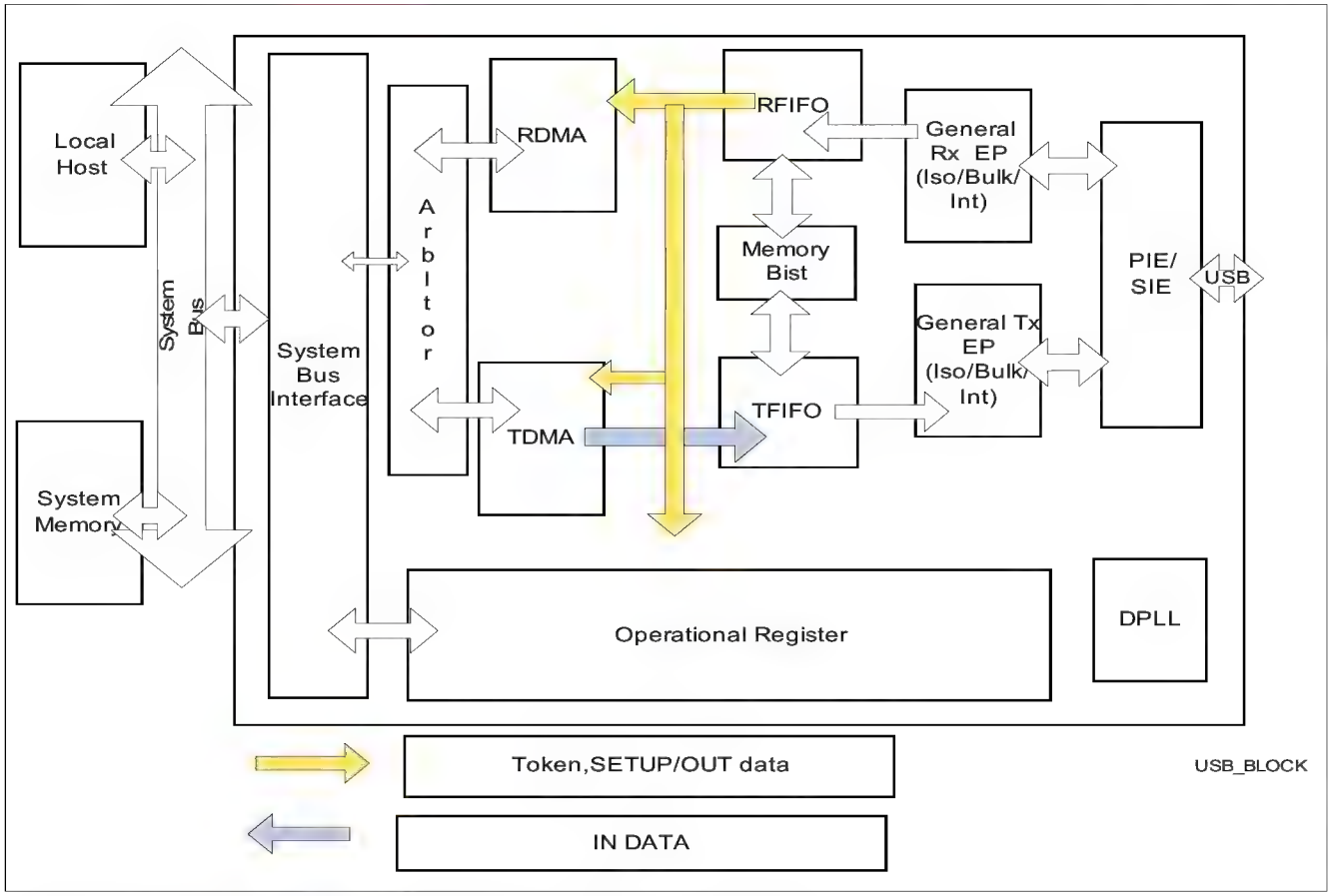


Figure 14 Block Diagram of Infineon USB 1.1 Host Controller

8.2.2 System Bus Interface

This block provides the USB Host controller with the connection to the AHB bus interface. The AHB bus is a 32-bit wide data bus, high-performance pipeline architecture. This block contains the AHB master interface and slave interface. The Host can program the USB Host controller operational register via the AHB slave interface. The DMA units within the USB Host controller will act as bus masters and access the system memory through the AHB master interface.

8.2.3 Operational Register

This block is the CSR (configure and status register) of USB 1.1 Host controller. The local host configures USB 1.1 Host controller via these registers. It includes DMA, endpoint, enable/disable, and interrupt control. The local host gets the status of the USB 1.1 Host controller by reading the registers. It includes the DMA, interrupt and USB bus status. The operational register also provides the interface for the local host to transfer the data for control and interrupt endpoint.

8.2.4 SIE

The SIE handles the link layer protocol of USB. It includes the following items

- Identify the USB SYNC field
- Identify the USB address, endpoint field
- Decode/encode the NRZI
- Generate/check the Bit Stuffing and the CRC
- Convert the USB incoming serial data to 8-bit parallel data

- Convert 8-bit parallel data to USB serial data
- Detect/report/generate USB bus events such as Reset, Suspend and Resume

8.2.5 DPLL

The DPLL block is a digital phase lock loop for extracting clock and data from the USB bus.

8.2.6 Memory BIST

The Memory BIST block is used for testing TFIFO and RFIFO. In this memory BIST, the MARCH C- test algorithm is adopted and the test data bus is 32 bits in width for each FIFO block. During the test period, all FIFO blocks are tested concurrently and the test procedure will be aborted if any fault is detected.

8.3 DMA Operation

3 kinds of Endpoints data transfer (Control, Interrupt and Bulk) are supported in host mode.

8.3.1 Registers Description

Table 40 Registers Address Space

Module	Base Address	End Address	Note
–	$–_H$	$–_H$	–

Table 41 Registers Overview

Register Short Name	Register Long Name	Offset Address	Page Number
Control_Reg	Control Register	H	185
Tail_Trans_Des	Tail Transfer Descriptor	H	186
Head_Trans_Des	Head Transfer Descriptor	H	186
Next_Endp_Trans_Des	Next Endpoint Transfer Descriptor	H	186
Status_Reg	Status Register	H	187
Data_Buf_P	Data Buffer Pointer	H	188
Contr_Buf_L	Controller/Buffer Length	H	190
Next_Tra_Des_P	Next Transfer Descriptor Pointer	H	190

The register is addressed wordwise.

Table 42 Registers Access Types

Mode	Symbol	Description Hardware (HW)	Description Software (SW)
Basic Access Types			
read/write	rw	Register is used as input for the HW	Register is read and writable by SW
read/write virtual	rwv	Physically, there is no new register in the generated register file. The real readable and writable register resides in the attached hardware.	Register is read and writable by SW (same as rw type register)
read	r	Register is written by HW (register between input and output -> one cycle delay)	Value written by SW is ignored by HW; that is, SW may write any value to this field without affecting HW behavior
read only	ro	Same as r type register	Same as r type register
read virtual	rv	Physically, there is no new register in the generated register file. The real readable register resides in the attached hardware.	Value written by SW is ignored by HW; that is, SW may write any value to this field without affecting HW behavior (same as r type register)
write	w	Register is written by software and affects hardware behavior with every write by software.	Register is writable by SW. When read, the register does not return the value that has been written previously, but some constant value instead.
write virtual	wv	Physically, there is no new register in the generated register file. The real writable register resides in the attached hardware.	Register is writable by SW (same as w type register)
read/write hardware affected	rwh	Register can be modified by hardware and software at the same time. A priority scheme decides, how the value changes with simultaneous writes by hardware and software.	Register can be modified by HW and SW, but the priority SW versus HW has to be specified. SW can read the register.

Table 43 Registers Clock Domains

Clock Short Name	Description
–	–

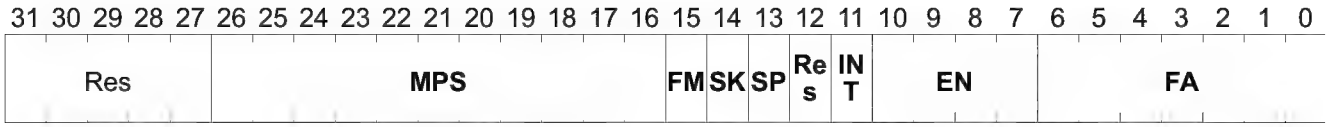
8.3.1.1 Registers

Endpoint Descriptor Format

	31 0
DWORD 0	Control
DWORD 1	Tail Transfer Descriptor
DWORD 2	Head Transfer Descriptor
DWORD 3	Next Endpoint Transfer Descriptor

Control Register

Control_Reg	Offset	Reset Value
Control Register	H	0_H



Field	Bits	Type	Description
Res	31:27		**Reserved**
MPS	26:16		**Maximum Packet Size** The maximum data that can be transmited/received in one USB transaction.
FM	15		**Format** This bit indicates that this packet is for isochronous. 0_B The data in this descriptor is for general data transfer 1_B The data in this descriptor is for isochronous transfer
SK	14		**Skip** When this bit is set, DMA will continue on to the next descriptor in the link list, this is used for isochronous and periodic data transmission/reception.
SP	13		**Speed** This bit indicates the speed of the data transfer.
Res	12		**Reserved**
INT	11		**Interrupt** This bit indicates that this ED is an interrupt endpoint.
EN	10:7		**Endpoint Number** Endpoint number of the current USB function.
FA	6:0		**Function Address** Function address of the current USB device.

Tail Transfer Descriptor

Tail_Trans_Des	Offset	Reset Value
Tail Transfer Descriptor	H	0_H

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SA																												Res			

Field	Bits	Type	Description
SA	31:4		**Starting Address** Starting address of the tail transfer descriptor in host memory space.
Res	3:0		**Reserved**

Head Transfer Descriptor

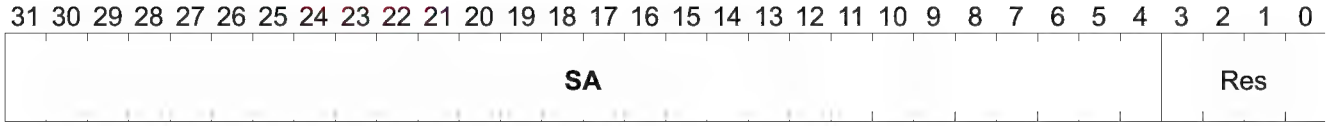
Head_Trans_Des	Offset	Reset Value
Head Transfer Descriptor	H	0_H

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SA																												Res		TL	HALT

Field	Bits	Type	Description
SA	31:4		**Starting Address** Starting address of the head transfer descriptor in host memory space.
Res	3:2		**Reserved**
TL	1		**Togglecarry** This bit indicates the current toggle value in this transaction.
HALT	0		**Halt** This bit indicates that this endpoint is halted due to error.

Next Endpoint Transfer Descriptor

Next_Endp_Trans_Des	Offset	Reset Value
Next Endpoint Transfer Descriptor	H	0_H



Field	Bits	Type	Description
SA	31:4		**Starting Address** Starting address of the next endpoint transfer descriptor in host memory space.
Res	3:0		**Reserved**

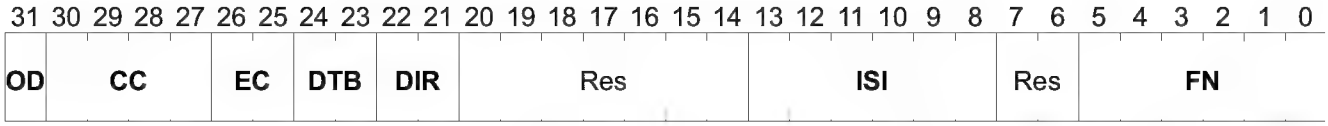
8.3.1.2 Registers

Transfer Descriptor Format

	31 0
DWORD 0	Status
DWORD 1	Data Buffer Pointer
DWORD 2	Controller/Buffer Length
DWORD 3	Next Transfer Descriptor Pointer

Status Register

Status_Reg	Offset	Reset Value
Status Register	H	0_H

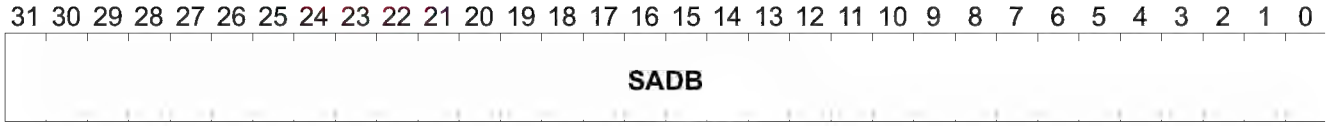


Field	Bits	Type	Description
OD	31		**Owner Descriptor** Descriptor ownership bit – set to 0 when the host owns the descriptor, set to 1 by the host to tell the USB Host controller it owns the descriptor, the controller will clear this bit when reception has been done.

Field	Bits	Type	Description
CC	30:27		**Complete Code** The transfer status of each USB transfer. 0000_B No Error 0001_B CRC Check Error 0010_B Bit-Stuffing Error 0011_B Data Toggle Error 0100_B STALL 0101_B Device No Response (Timeout) 0110_B PID Error (Invalid PID) 0111_B Unexpected PID 1000_B Data Overrun (Packet Overrun) 1001_B Data Underrun (Packet Underrrun) 1100_B Buffer Overrun 1101_B Buffer Underrrun
EC	26:25		**Error Count** Error count the error that happens at each USB transfer.
DTB	24:23		**Data Toggle Bit** This field is used for data PID value. When 1, use but 23 as the toggle bit. 24_B When 0, use togglecarry bit in ED as the PID 23_B Toggle value
DIR	22:21		**Direction** These bits indicate this packet's direction. 00_B Setup packet 01_B Out packet 10_B IN packet 11_B **Res** Reserved
Res	20:14		**Reserved**
ISI	13:8		**Interrrupt Service Interval** This field indicates the frame interval where the interrupt transaction occurs. The frame interval = bit [13:8] + 1
Res	7:6		**Reserved**
FN	5:0		**Frame Number** This field indicates the frame number that receive/transmit this data, this field is only valid when configured in Isochronous and interrupt transaction. For Isochronous transaction, it indicates the frame number in which the isochronous transaction should occur. For interrupt transaction, software uses this field to indicate to hardware for the "starting frame number" of the interrupt transaction, hardware will update this field to the "next frame number" after the current transaction is done.

Data Buffer Pointer

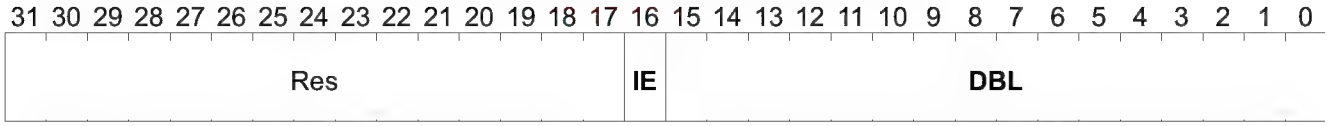
Data_Buf_P	Offset	Reset Value
Data Buffer Pointer	H	0_H



Field	Bits	Type	Description
SADB	31:0		**Starting Address of the Data Buffer** This field indicates the starting address of the data buffer. Data buffer may be aligned on any byte. When an OUT or SETUP packet has been transmitted, this field will be updated as the next start address of the data buffer.

Controller/Buffer Length

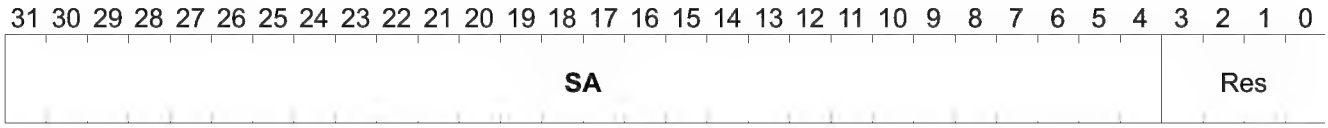
Contr_Buf_L	Offset	Reset Value
Controller/Buffer Length	H	0_H



Field	Bits	Type	Description
Res	31:17		**Reserved**
IE	16		**Interrupt Enable** This field indicates whether the interrupt will be asserted when this descriptor is completed.
DBL	15:0		**Length of Data Buffer** This field indicates the length of the current data buffer.

Next Transfer Descriptor Pointer

Next_Tra_Des_P	Offset	Reset Value
Next Transfer Descriptor Pointer	H	0_H



Field	Bits	Type	Description
SA	31:4		**Starting Address** Starting address of the next descriptor in host memory space.
Res	3:0		**Reserved**

8.3.2 DMA Operation

To provide a high-performance and effective way for software packet scheduling, the DMA is able to handle both transmit and receive packets in a single descriptor chain. In the endpoint and transfer descriptors, the software can specify the descriptor format (Isochronous or none-Isochronous), direction, speed, and data toggle bit.

If there is any isochronous or periodic data that needs to be transmitted/received, this descriptor needs to link at the beginning of the link list to guarantee the bus bandwidth. After these descriptors, the control or bulk descriptor is linked.

DMA starts to access the first descriptor in the link list and transmit/receive the data through the USB bus. Since there might be several USB packets segmented in one descriptor. After one USB packet is transmitted, DMA will

update the **transmit status**,**data length**,**start address of the data buffer**, and **length of data buffer** for further access, and advance to the next descriptor.

When the DMA finishes it's transmit/receive of a descriptor, it depends on the setting of the **interrupt enable** to generate HC_INT to indicate this descriptor is ready for the software driver process.

If all the descriptors have been accessed once, and the frame is not yet over, then the DMA will try to access the general descriptor again in order to get a high performance.

If a USB zero length packet is received, then the received data length will be zero, and this buffer is retired due to short packet received.

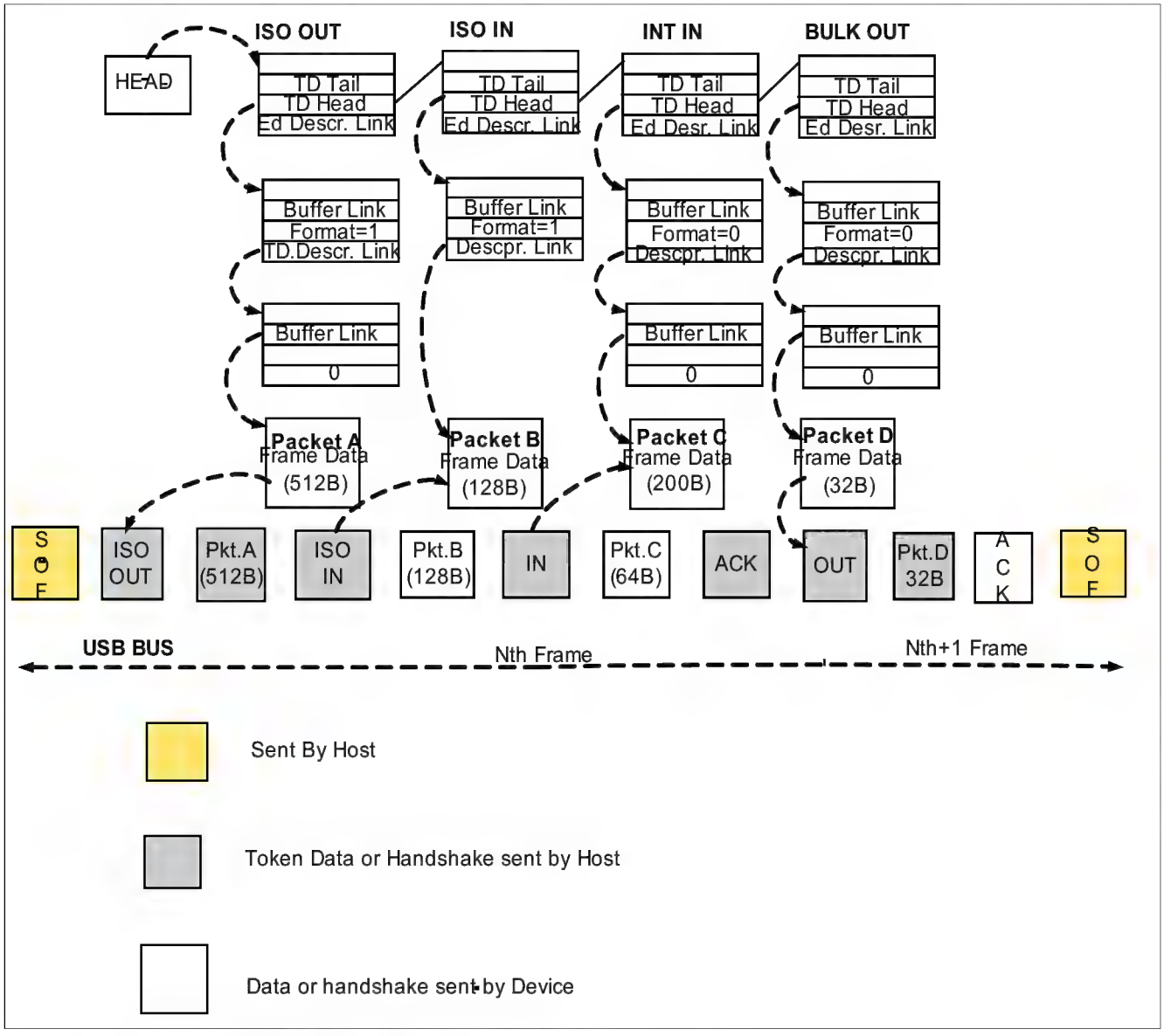


Figure 15 DMA Operation in Host Mode

For Interrupt IN/OUT transactions, each ED just contains one valid TD. Since the Interrupt transaction is periodic, two parameters are defined in TD by software to guide hardware for doing Interrupt transfer, they are Frame Number and Interrupt service period. The Frame Number is used by the software to indicate the frame number of which the first Interrupt transaction occurs, of this TD. The Interrupt service period indicates the frame interval between the current Interrupt transaction and the next one, Frame_Interval is calculated by the following formula:

Frame_Internal = (Interrupt service period + 1)

The transfer of interrupt transaction is activated just when the current frame number matches the Frame Number of the TD, after the current transaction is served, the next frame number will be updated to TD descriptor by hardware, then the hardware waits for the next matched frame number to serve the Interrupt transaction, and so on. The next Frame Number is calculated by (current_Frame_Number) + Frame_Interval. The following diagram describes how Frame_Number and Interrupt_service_period work.

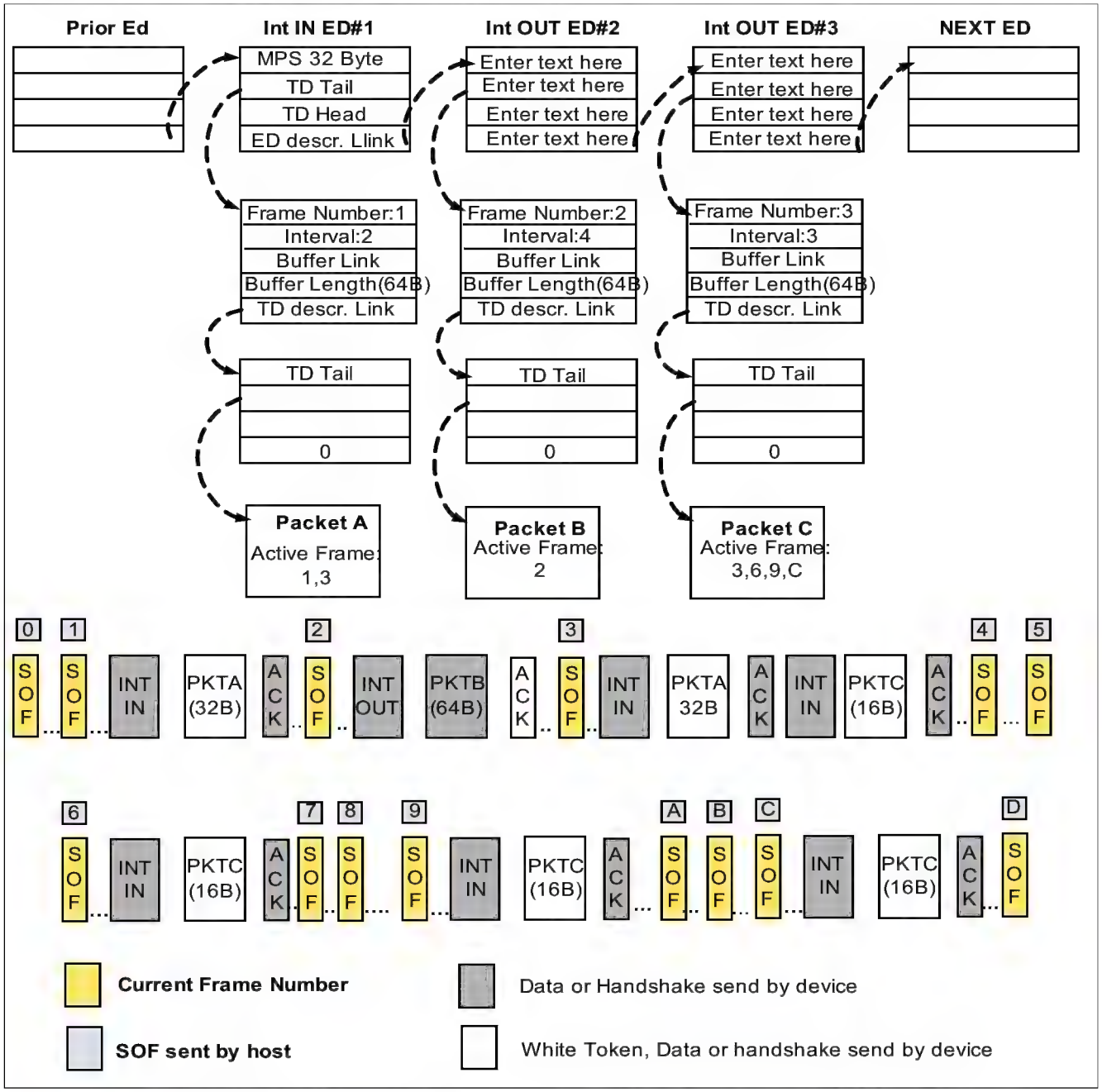


Figure 16 Interrupt IN/OUT Transactions

8.4 USB Control Status Register Map

Table 44 Registers Address Space

Module	Base Address	End Address	Note
USB Control Status	$1120\ 0000_H$	$1120\ 0080_H$	–

Table 45 Registers Overview

Register Short Name	Register Long Name	Offset Address	Page Number
GC	General Control	00_H	195
INT_S	Interrupt Status	04_H	196
INT_E	Interrupt Enable	08_H	197
Res_6	Reserved 6	$0C_H$	198
H_Gen_Cntl	Host General Control	10_H	198
Res_7	Reserved 7	14_H	198
SOF_FI	SOF Frame Interval	18_H	200
SOF_FN	SOF Frame Number	$1C_H$	201
RR0	Reserved 0	20_H	202
RR_1	Reserved Register 1	21_H	202
RR_2	Reserved Register 2	22_H	202
RR_76	Reserved Register 76	$6C_H$	202
Low_STh	Low Speed Threshold	70_H	203
RH_D	RH Descriptor	74_H	203
PX_St	Port X Status	78_H	206
HDHS_Ad	Host Descriptor Head Starting Address	80_H	210

The register is addressed wordwise.

Table 46 Registers Access Types

Mode	Symbol	Description Hardware (HW)	Description Software (SW)
Basic Access Types			
read/write	rw	Register is used as input for the HW	Register is read and writable by SW
read/write virtual	rwv	Physically, there is no new register in the generated register file. The real readable and writable register resides in the attached hardware.	Register is read and writable by SW (same as rw type register)
read	r	Register is written by HW (register between input and output -> one cycle delay)	Value written by SW is ignored by HW; that is, SW may write any value to this field without affecting HW behavior
read only	ro	Same as r type register	Same as r type register
read virtual	rv	Physically, there is no new register in the generated register file. The real readable register resides in the attached hardware.	Value written by SW is ignored by HW; that is, SW may write any value to this field without affecting HW behavior (same as r type register)
write	w	Register is written by software and affects hardware behavior with every write by software.	Register is writable by SW. When read, the register does not return the value that has been written previously, but some constant value instead.
write virtual	wv	Physically, there is no new register in the generated register file. The real writable register resides in the attached hardware.	Register is writable by SW (same as w type register)
read/write hardware affected	rwh	Register can be modified by hardware and software at the same time. A priority scheme decides, how the value changes with simultaneous writes by hardware and software.	Register can be modified by HW and SW, but the priority SW versus HW has to be specified. SW can read the register.

Table 47 Registers Clock Domains

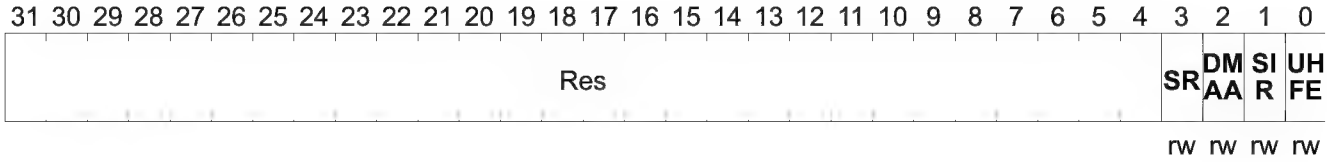
Clock Short Name	Description
–	–

8.4.1 USB Control Status Registers Description

Host processors can only access USB 1.1 host/device controller registers with double word (32 bits) reads or writes on double word boundaries.

General Control

GC	Offset	Reset Value
General Control	00_H	0_H



Field	Bits	Type	Description
Res	31:4		**Reserved** Not Applicable.
SR	3	rw	**Software Reset, Both Modes** Setting this bit resets the device controller to its initial state. This bit is auto-cleared after reset. Writing a 0 to this bit takes no effect.
DMAA	2		**DMA Arbitration Control, Both Modes** 0_B Receive = Transmit (1:1) 1_B Receive > Transmit
SIR	1		**Software Interrupt Request, Both Modes** When this bit is set to 1, the controller's interrupt pin becomes active. Reading this bit always returns zero.When SW_INT in interrupt is clear, this bit is clear as well.
UHFE	0		**USB Host Function Enable, Both Modes** This bit enables the USB host functions, when 1'b1, the controller acts as USB host.

Interrupt Status

INT_S	Offset	Reset Value
Interrupt Status	04_H	0_H

31	30	29	28:26	25:21	20	19:12	11	10	9	8	7	6	5	4	3:0
INTA	FATI	SWI	Res	Res	TDC	Res	FNO	SO	INS*	BABI	Res	Res	RESI	SOFI	Res
ro	rw1c	rw1c			rw1c		rw1c	rw1c	rw1c	rw1c			rw1c	rw1c	

Field	Bits	Type	Description
INTA	31	ro	**Interrupt Active** When this bit is set, it indicates that at least one unmasked interrupt status is set.
FATI	30	rw1c	**Fatal Interrupt, Device Mode** Reserved. Host mode: 1_B Fatal system bus error occurs
SWI	29		**Software Interrupt, Both Modes** 1_B Software Interrupt. This bit is set when software set one to SW_INT_REQ 00_H, and is cleared after software writes one to this bit.
Res	28:26		**Reserved** Not Applicable
Res	25:21		**Reserved** Not Applicable
TDC	20	rw1c	**A TD is Completed**
Res	19:12		**Reserved** Not Applicable
FNO	11	rw1c	**Frame Number Overflow** This bit is set when the MSB of the frame number changes.
SO	10		**Scheduling Overrun** This bit is set when USB schedules for current frame overruns.
INSMI	9		**Root Hub Status Change** 1_B Detected device insertion or remove. This bit will only be set for the device or hub, which is attached to host directly.
BABI	8		**Babble Detected, Host Mode** 1_B Detected babble
Res	7		**Reserved** Not Applicable
Res	6		**Reserved** Not Applicable

Field	Bits	Type	Description
RESI	5	rw1c	**Resume Detected** 1_B USB resume event is detected. Controller sets this bit to one when resume signal is detected on USB bus.
SOFI	4		**SOF Transmitted/Received, Host Mode** 1_B Issue a SOF token. The frame number value is stored in $1C_H$ Frame Number
Res	3:0		**Reserved** Not Applicable

Interrupt Enable

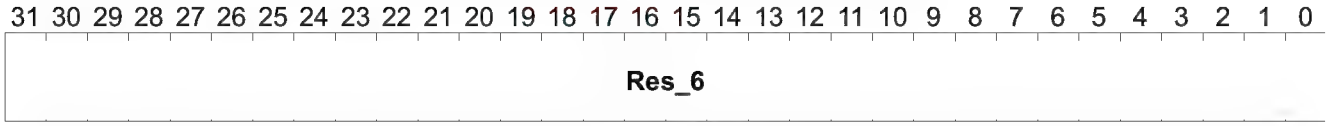
INT_E	Offset	Reset Value
Interrupt Enable	**08_H**	**0_H**

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
INTE	INTM																														
	rw																														

Field	Bits	Type	Description
INTE	31		**Interrupt Enable** 0_B Disable the controller to assert interrupt 1_B Enable the controller to assert interrupt
INTM	30:0	rw	**Interrupt Mask** Bits are set to allow the corresponding interrupts (bit 21:0 in Interrupt Status register) to generate an interrupt request. And cleared to prevent the interrupt from happening.

Reserved 6

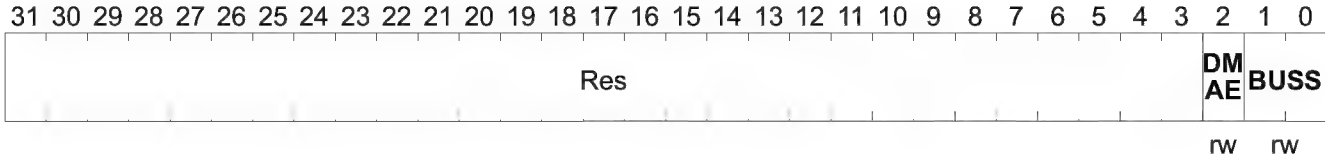
Res_6	Offset	Reset Value
Reserved 6	$0C_H$	0_H



Field	Bits	Type	Description
Res_6	31:0		**Reserved** Not Applicable.

Host General Control

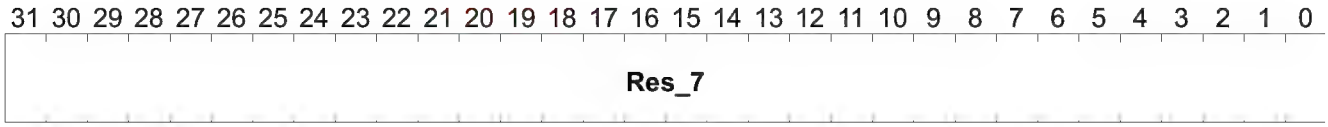
H_Gen_Cntl	Offset	Reset Value
Host General Control	10_H	0_H



Field	Bits	Type	Description
Res	31:3		**Reserved** Not Applicable.
DMAE	2	rw	**USB Host DMA Enable** This bit enables the host controller DMA functionality. When enabled the DMA will start to fetch the descriptor for processing.
BUSS	1:0		**USB Bus State** A transition to USB operational state will cause the SOF generation to start 1 ms later. 00_B USB reset state. 01_B USB resume state 10_B USB operational state 11_B USB suspend state.

Reserved 7

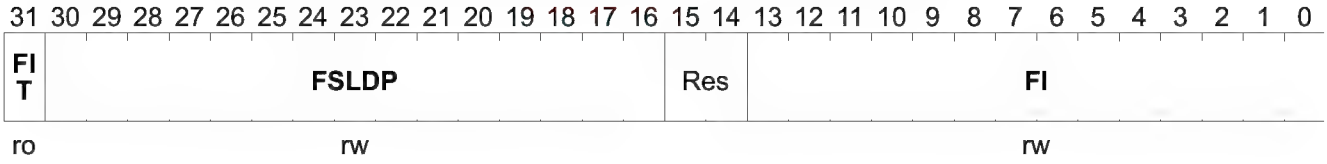
Res_7	Offset	Reset Value
Reserved 7	14_H	0_H



Field	Bits	Type	Description
Res_7	31:0		**Reserved** Not Applicable

SOF Frame Interval

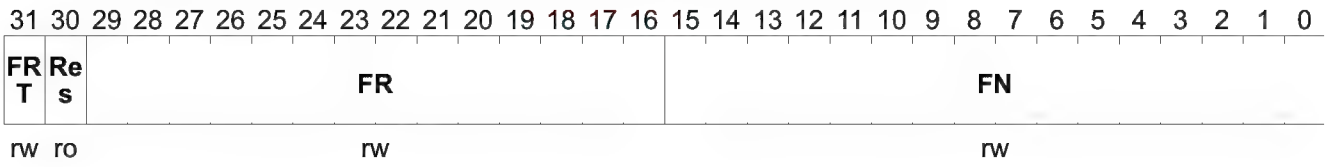
SOF_FI	Offset	Reset Value
SOF Frame Interval	18_H	$2EDF_H$



Field	Bits	Type	Description
FIT	31	ro	**Frame Interval Toggle** Software toggles this bit whenever it loads a new value to FM_INTERVAL.
FSLDP	30:16	rw	**FS Largest Data Packet** This field specifies a value which is loaded into the Largest Data Packet Counter at the beginning of each frame. The counter value represents the largest amount of data in bits which can be sent or received by the HC in a single transaction at any given time without causing scheduling overrun. The field value is calculated by the software.
Res	15:14		**Reserved** Not Applicable
FI	13:0	rw	**Frame Interval** This specifies the interval between two consecutive SOFs in bit times. The nominal value is set to be 11,999. Software should store the current value of this field before resetting HC.

SOF Frame Number

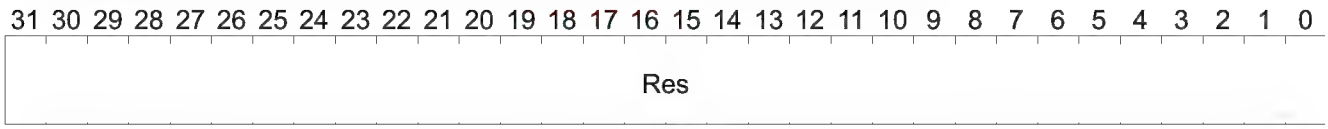
SOF_FN	Offset	Reset Value
SOF Frame Number	$1C_H$	0_H



Field	Bits	Type	Description
FRT	31	rw	**Frame Remaining Toggle** This bit is loaded from the FM_INTERVAL_TOG field of FM_INTERVAL whenever FM_REMAIN remaining reaches 0. This bit is used by software for the synchronization between FM_INTERVALand FM_REMAIN.
Res	30	ro	**Reserved**
FR	29:16	rw	**Frame Remaining** This counter is decremented at each bit time. When it reaches zero, it is reset by loading the frame Interval value specified in FM_INTERVAL at the next bit time boundary. When entering the USBOPERATIONAL state, HC re-loads the content with the FM_INTERVAL of and uses the updated value from the next SOF.
FN	15:0		**Frame Number** This field is a 16-bit counter. It provides a timing reference among events happening in the Host Controller and the Host Controller Driver. The Host Controller Driver may use the 16-bit value specified in this register and generate a 32-bit frame number without requiring frequent access to the register.

Reserved 0

RR0 | **Offset** | **Reset Value**
Reserved 0 | **20_H** | **0_H**



Field	Bits	Type	Description
Res	31:0		**Reserved** Not Applicable.

Similar Registers

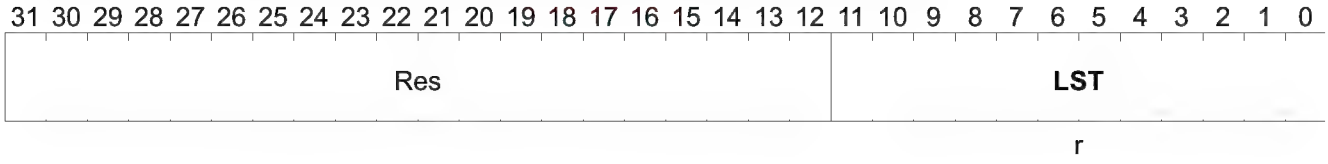
Other Reserved Registers have the same structure and characteristics as **Reserved 0**; the names and offset addresses are listed in **Table 48**.

Table 48 Reserved Registers

Register Short Name	Register Long Name	Offset Address	Page Number
RR_1	Reserved Register 1	21_H	
RR_2	Reserved Register 2	22_H	
...	...	...$_H$	
RR_76	Reserved Register 76	$6C_H$	

Low Speed Threshold

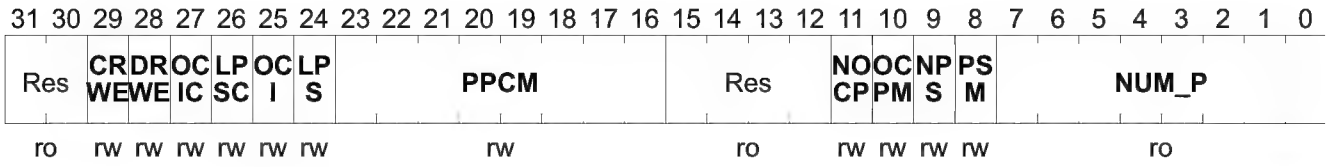
Low_STh	Offset	Reset Value
Low Speed Threshold	70_H	628_H



Field	Bits	Type	Description
LST	11:0	r	**Low Speed Threshold** This field contains a value which is compared to the FM_REMAIN field prior to initiating a Low Speed transaction. The transaction is started only if FM_REMAIN > = this field. The value is calculated by HCD with the consideration of transmission and setup overhead.
Res	31:12		**Reserved**

RH Descriptor

RH_D	Offset	Reset Value
RH Descriptor	74_H	1_H



Field	Bits	Type	Description
Res	31:30	ro	**Reserved** Not Applicable.

Field	Bits	Type	Description
CRWE	29	rw	**Clear Remote Wakeup Enable** 0_B Has no effect. 1_B Clears Device Remove Wakeup Enable
DRWE	28		**Device Remote Wakeup Enable** This bit enables a Connect Status Change bit as a resume event, causing a USBSUSPEND to USBRESUME state transition and setting the Resume Detected interrupt. 0_B Connect Status Change is not a remote wakeup event 1_B Connect Status Change is a remote wakeup event
OCIC	27		**Over Current Indication Change** This bit is set by hardware when a change has occurred to the OCI field of this register. The HCD clears this bit by writing a 1. Writing a 0 has no effect.
LPSC	26		**Local Power Switch Change (read)** This bit is always read as 0. **Set Global Power (write)** In global power mode (PSM =0), This bit is written to 1 to turn on power to all ports (clearPPS). In per-port power mode, it sets PPS only on ports whose PPCM bit is not set. Writing a 0 has no effect.
OCI	25		**Over Current Indication** This bit reports overcurrent conditions when the global reporting is implemented. When set, an overcurrent condition exists. When cleared, all power operations are normal. If per-port overcurrent protection is implemented this bit is always 0
LPS	24		**Local Power Switch (read)** This bit is always read as 0. **Clear Global Power (write)** In global power mode (PSM =0), This bit is written to 1 to turn off power to all ports (clearPPS). In per-port power mode, it clears PPS only on ports whose PPCM bit is not set. Writing a 0 has no effect.
PPCM	23:16		**Port Power Control** Each bit indicates if a port is affected by a global power control command when PSM is set. When set, the port's power state is only affected by per-port power control (Set/ClearPortPower). When cleared, the port is controlled by the global power (switchSet/ClearGlobalPower). If the device is configured to global switching mode (PSM =0), this field is not valid. Bit 0: Reserved Bit 1: Ganged-power mask on Port #1 Bit 2: Ganged-power mask on Port #2 ... Bit7: Ganged-power mask on Port #7
Res	15:12	ro	**Reserved** Not Applicable

Field	Bits	Type	Description
NOCP	11	rw	**No Over Current Protect** This bit describes how the overcurrent status for the Root Hub ports are reported. When this bit is cleared, the OCPM field specifies global or per-port reporting. 0_B Over-current status is reported collectively for all downstream ports 1_B No overcurrent protection supported
OCPM	10		**Over Current Protect Mode** This bit describes how the overcurrent status for the Root Hub ports are reported. At reset, this fields should reflect the same mode as PSM. This field is valid only if the NOCP field is cleared. 0_B Over-current status is reported collectively for all downstream ports 1_B Over-current status is reported on a per-port basis
NPS	9		**No Power Switch** These bits are used to specify whether power switching is supported or port are always powered. It is implementation-specific. When this bit is cleared, the PSM specifies global or per-port switching. 0_B Ports are power switched 1_B Ports are always powered on when the HC is powered on
PSM	8		**Power Switch Mode** This bit is used to specify how the power switching of the Root Hub ports is controlled. It is implementation-specific. This field is only valid if the NPS field is cleared. 0_B All ports are powered at the same time 1_B Each port is powered individually. This mode allows portpower to be controlled by either the global switch or per-port switching. If the PPCM bit is set per-port switching. If the PPCM bit is set, the port responds only to port power commands (Set/ClearPortPower). If the port mask is cleared, then the port is controlled only by the global power switch (Set/ClearGlobalPower).
NUM_P	7:0	ro	**Number Port**

Port X Status

PX_St	Offset	Reset Value
Port X Status	78_H	0_H

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Res											PRSC	OCIC	PSSC	PESC	CSC	Res						LSDV	PPS	Res			PRS	POCI	PSS	PES	CCS
ro											rw	rw	rw	rw	rw	ro						rw	rw	ro			rw	rw	rw	rw	rw

Field	Bits	Type	Description
Res	31:21	ro	**Reserved** Not Applicable.
PRSC	20	rw	**Port Reset Status Change** This bit is set at the end of the 10 ms port reset signal. The HCD writes a 1 to clear this bit. Writing a 0 has no effect. 0_B Port reset is not complete 1_B Port reset is complete
OCIC	19		**Over Current Indicator Change** This bit is valid only if overcurrent conditions are reported on a per-port basis. This bit is set when Root Hub changes the POCI bit. The HCD writes a 1 to clear this bit. Writing a 0 has no effect. 0_B No change in POCI 1_B OCI has changed
PSSC	18		**Port Suspend Status Change** This bit is set when the full resume sequence has been completed. This sequence includes the 20 s resume pulse, LS EOP, and 3 ms re synchronization delay. The HCD writes a 1 to clear this bit. Writing a 0 has no effect. This bit is also cleared when RSC is set. 0_B Resume is not completed 1_B Resume completed
PESC	17		**Port Enable Status Change** This bit is set when hardware events cause the PES bit to be cleared. Changes from HCD writes do not set this bit. The HCD writes a 1 to clear this bit. Writing a 0 has no effect. 0_B No change in PES 1_B Change in PES

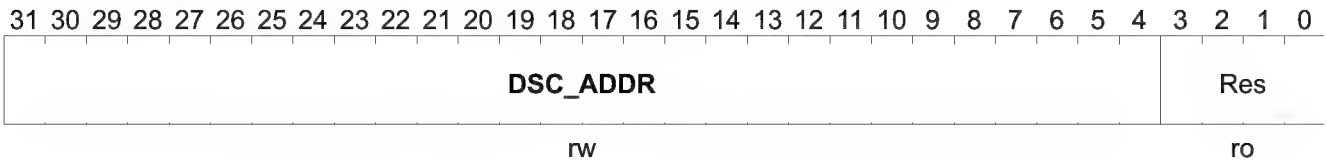
Field	Bits	Type	Description
CSC	16	rw	**Connect Status Change** This bit is set whenever a connect or disconnect event occurs. The HCD writes a 1 to clear this bit. Writing a 0 has no effect. If CCS is cleared when a SPR, SPE, or SPS write occurs, this bit is set to force the driver to re-evaluate the connection status since these writes should not occur if the port is disconnected. *Note: This bit is set only after a Root Hub reset to inform the system that the device is attached.* 0_B No change in CCS 1_B Change in CCS
Res	15:10	ro	**Reserved** Not Applicable.
LSDV	9	rw	**Low Speed Device Attached (read)** This bit indicates the speed of the device attached to this port. When set, a Low Speed device is attached to this port. When clear, a Full Speed device is attached to this port. This field is valid only when the CurrentConnectStatus is set. 0_B Full speed device attached 1_B Low speed device attached **Clear Port Power (write)** The HCD clears the PortPowerStatus bit by writing a 1 to this bit. Writing a 0 has no effect.
PPS	8		**Port Power Status (read)** This bit reflects the port's power status, regardless of the type of power switching implemented. This bit is cleared if an overcurrent condition is detected. HCD sets this bit by writing SPP or SGP. HCD clears this bit by writing CPP or CGP. Which power control switches are enabled is determined by PSM and PPCM[NDP] . In global switching mode (PSM =0), only Set/ClearGlobalPower controls this bit. In per-port power switching (PSM =1), if the PPCM[NDP] bit for the port is set, only Set/ClearPortPower commands are enabled. If the mask is not set, only Set/ClearGlobalPower commands are enabled. When port power is disabled, CCS,PES, PSS, and PRS should be reset. 0_B Port power is off 1_B Port power is on **Set Port Power (write)** The HCD writes a 1 to set the PPS bit. Writing a 0 has no effect. *Note: This bit is always reads 1 if power switching is not supported.*
Res	7:5	ro	**Reserved** Not Applicable.

Field	Bits	Type	Description
PRS	4	rw	**Port Reset Status (read)** When this bit is set by a write to SPR, port reset signaling is asserted. When reset is completed, this bit is cleared when PRSC is set. This bit cannot be set if CCS is cleared. 0_B Port reset signal is not active 1_B Port reset signal is active **Set Port Reset (write)** The HCD sets the port reset signaling by writing a 1 to this bit. Writing a 0 has no effect. If CCS is cleared, this write does not set PRS, but instead sets CSC. This informs the driver that it attempted to reset a disconnected port.

Field	Bits	Type	Description
POCI	3	rw	**Port Over Current Indicator (read)** This bit is only valid when the Root Hub is configured in such a way that overcurrent conditions are reported on a per-port basis. If per-port overcurrent reporting is not supported, this bit is set to 0. If cleared, all power operations are normal for this port. If set, an overcurrent condition exists on this port. This bit always reflects the overcurrent input signal. 0_B No overcurrent condition 1_B Overcurrent condition detected **Clear Suspend Status (write)** The HCD writes a 1 to initiate a resume. Writing a 0 has no effect. A resume is initiated only if PSS is set.
PSS	2		**Port Suspend Status (read)** This bit indicates the port is suspended or in the resume sequence. It is set by a SSS write and cleared when PSSC is set at the end of the resume interval. This bit cannot be set if CCS is cleared. This bit is also cleared when PRSC is set at the end of the port reset or when the HC is placed in the USBRESUME state. If an upstream resume is in progress, it should propagate to the HC. 0_B Port is not suspended 1_B Port is suspended **Set Port Suspend (write)** The HCD sets the PSS bit by writing a 1 to this bit. Writing a 0 has no effect. If CCS is cleared, this write does not set PSS; instead it sets CSC. This informs the driver that it attempted to suspend a disconnected port.
PES	1		**Port Enable Status (read)** This bit indicates whether the port is enabled or disabled. The Root Hub may clear this bit when an overcurrent condition, disconnect event, switched-off power, or operational bus error such as babble is detected. This change also causes PESC to be set. HCD sets this bit by writing SPE and clears it by writing CPE. This bit cannot be set when CCS is cleared. This bit is also set, if not already, at the completion of a port reset when RSC is set or port suspend when SSC is set. *Note: This informs the driver that it attempted to enable a disconnected port.* 0_B Port is disabled 1_B Port is enabled **Set Port Enable (write)** The HCD sets PortEnableStatus by writing a 1. Writing a 0 has no effect. If CCS is cleared, this write does not set PES, but instead sets CSC.This informs the driver that it attempted to enable a disconnected port.
CCS	0		**Current Connect Status (read)** This bit reflects the current state of the downstream port. 0_B No device connected 1_B Device connected **Clear Port Enable (write)** The HCD writes a 1 to this bit to clear the PES. Writing a 0 has no effect. The CCS is not affected by any write. *Note: This bit is always read 1 when the attached device is nonremovable*

Host Descriptor Head Starting Address

HDHS_Ad	Offset	Reset Value
Host Descriptor Head Starting Address	80_H	0_H



Field	Bits	Type	Description
DSC_ADDR	31:4	rw	**Descriptor Chain Address** This field indicates the starting address of the host mode descriptor chain. DMA read the descriptor from this location when it is first enabled.
Res	3:0	ro	**Reserved**

9 Electrical Characteristics

9.1 Absolute Maximum Ratings

Table 49 Absolute Maximum Ratings

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Supply Voltage	V_{CC}	-0.5	–	1.9	V	–
Input Voltage	V_I	-0.5	–	V_{CC} +0.3	V	–
Output Voltage	V_O	-0.5	–	V_{CC} +0.3	V	–
Storage Temperature	T_S	-65	–	150	°C	–
Ambient Temperature	T_A	-0	–	70	°C	–
ESD Protection	V_{ESD}	-0	–	2000	V	–

Attention: Stresses above the max. values listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit.

9.2 DC Characteristics

Table 50 DC Characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Supply Voltage	V_{CC}	1.7	1.8	1.9	V	–
I/O Supply Voltage	V_{IO_CC}	3.0	3.3	3.6	V	–
Power Supply Current	I_{CC}	–	–	–	mA	V_{CC} = 1.8 V
I/ O Power Supply Current	I_{IO_CC}	–	–	–	mA	V_{CC} = 3.3 V
Input Low Voltage	V_{IL}	-0.5	–	0.8	V	–
Input High Voltage	V_{IH}	2.0	–	3.8	V	–
Input Low Leakage Current	I_{ILL}	-10	–	10	µA	V_{IN} = 0.8 V
Input High Leakage Current	I_{IHL}	-10	–	10	µA	V_{IN} = 2.0 V
Output Low Voltage	V_{OL}	–	–	0.4	V	I_{OUT} = 2~8 mA
Output High Voltage	V_{OH}	2.4	–	–	V	I_{OUT} = 2~-8 mA
Input Pin Capacitance	C_{IP}	5	–	8	pF	–
Pin Inductance	L_{PI}	TBD	–	–	nH	–

9.3 AC Timing

9.3.1 SDRAM Interface

(Unit: ns, Min: best case, Max: worst case)

Table 51 SDRAM Interface Timing

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Clock cycle time	t_{CK}	–	11.4	–	ns	–
Command/address setup delay time in precharge stage	t_{PS}	1.5	–	–	ns	–
Command/address hold delay time in precharge stage	t_{PH}	1	–	–	ns	–
Command/address setup delay time in active stage	t_{AS}	1.5	–	–	ns	–
Command/address hold delay time in active stage	t_{AH}	1	–	–	ns	–
Command/address setup delay time in write stage	t_{WS}	1.5	–	–	ns	–
Command/address hold delay time in write stage	t_{WH}	1	–	–	ns	–
Command/address setup delay time in read stage	t_{RS}	1.5	–	–	ns	–
Command/address hold delay time in read stage	t_{RH}	1	–	–	ns	–

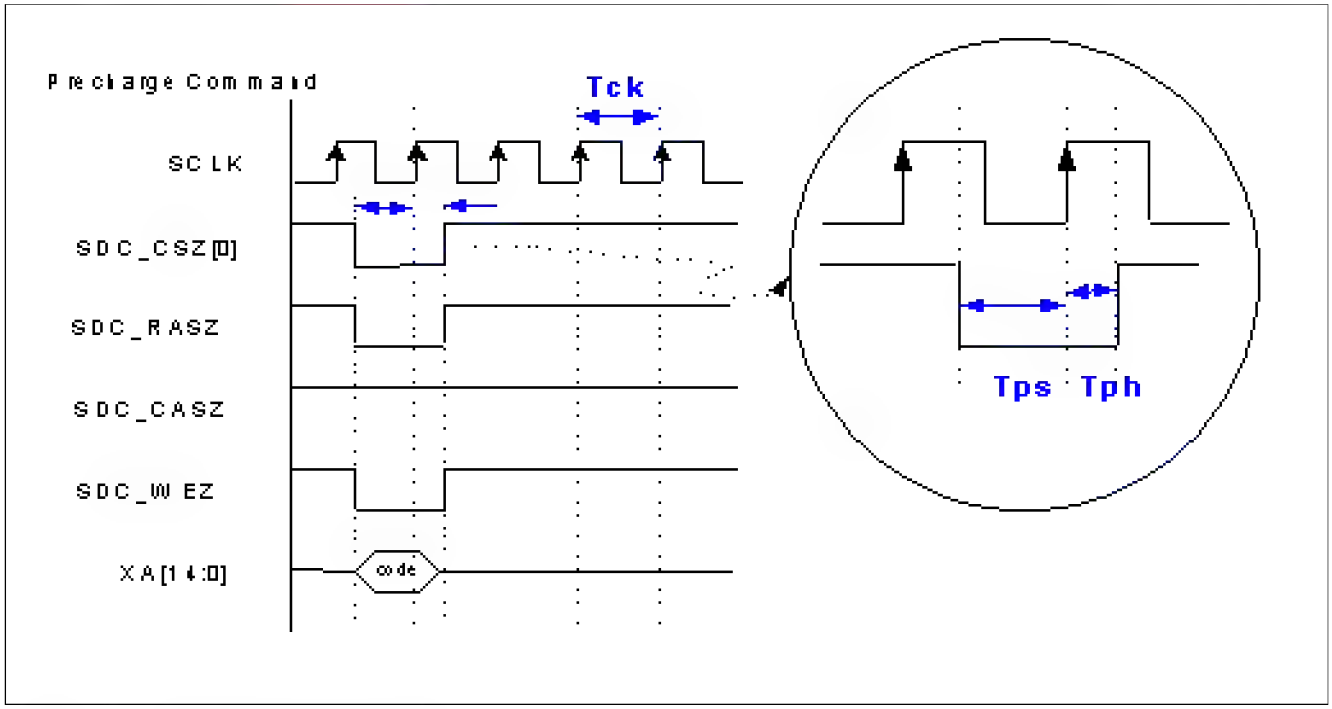


Figure 17 Precharge Command

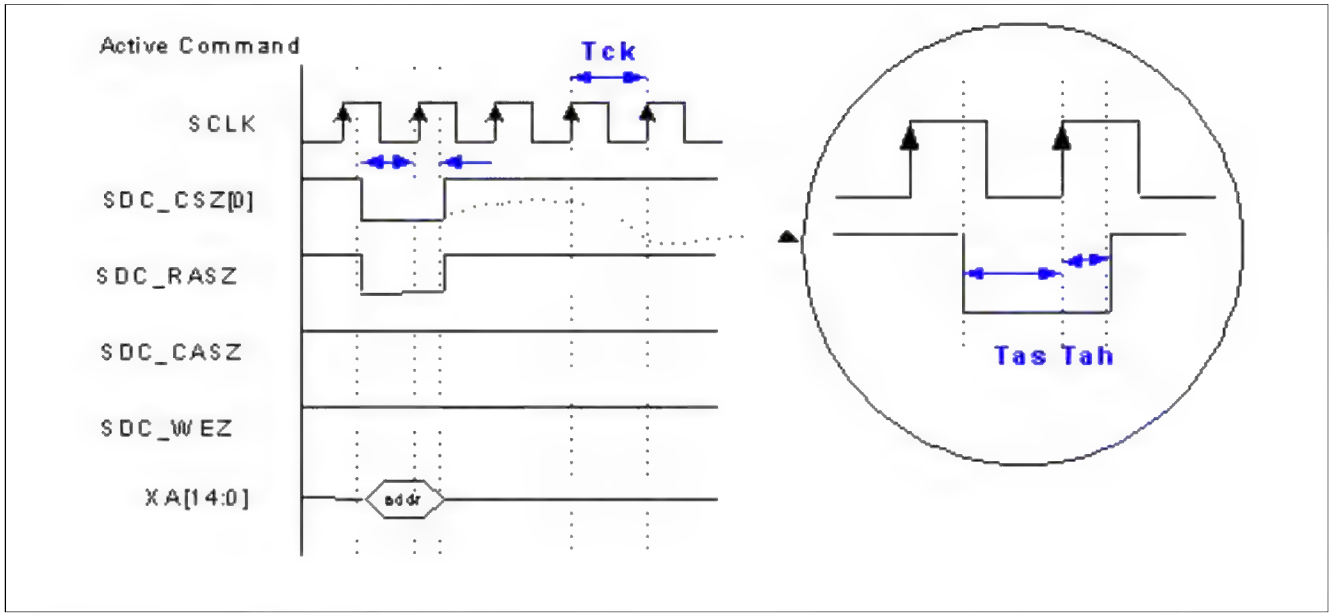


Figure 18 Active Command

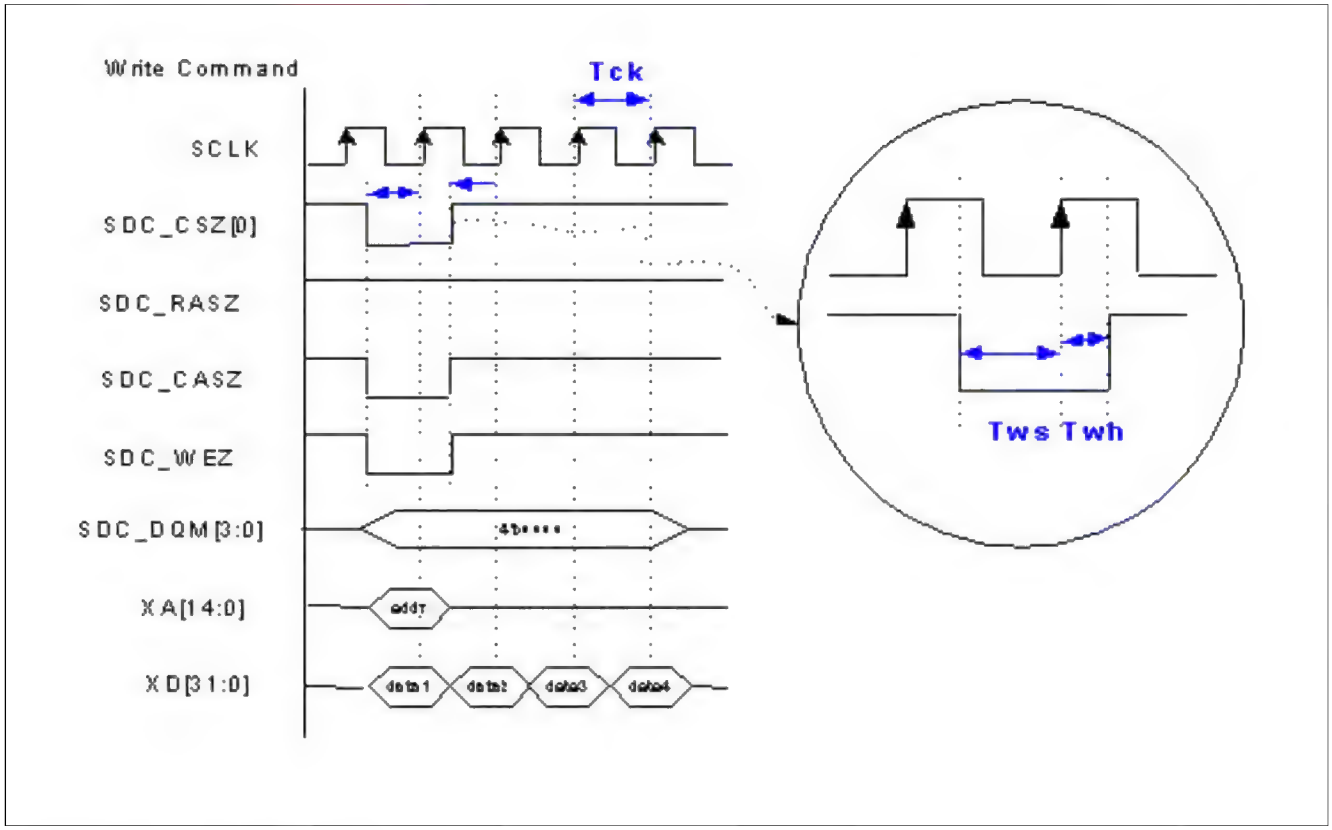


Figure 19 Write Command

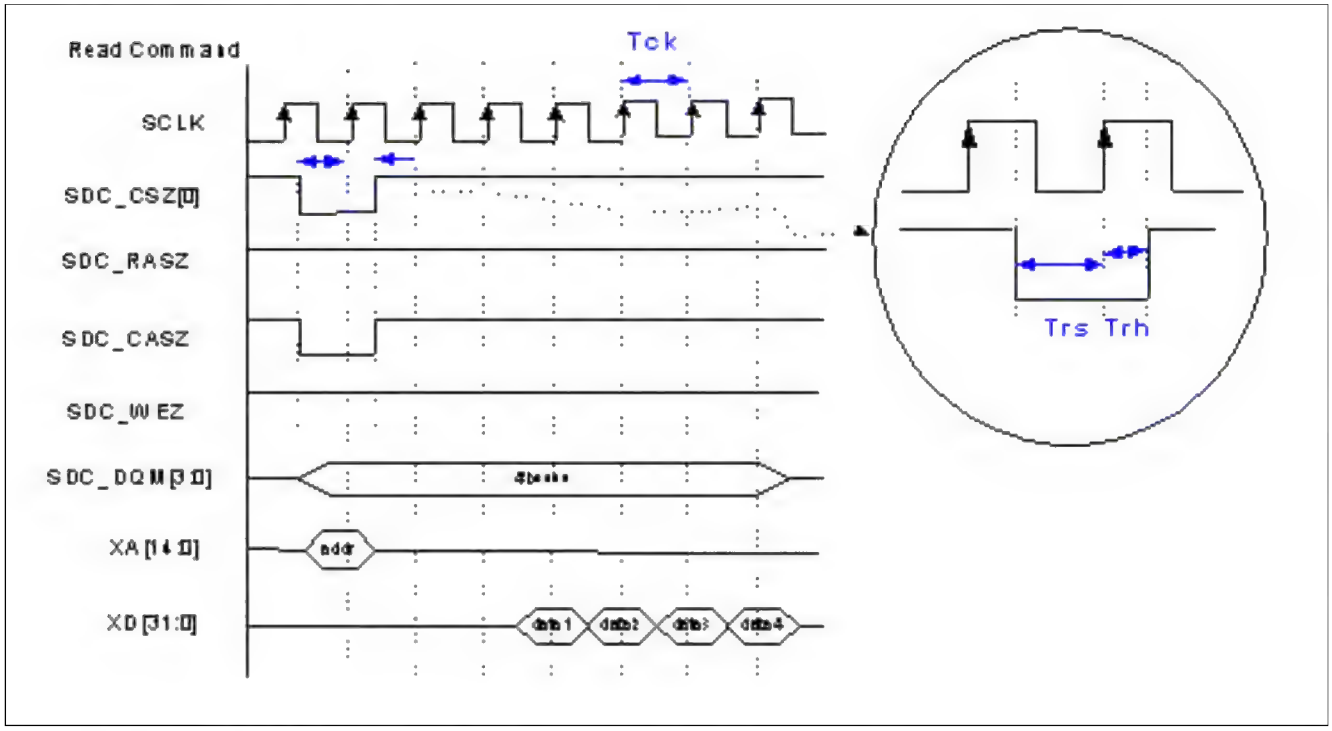


Figure 20 Read Command

9.3.2 Memory Bus Read Timing

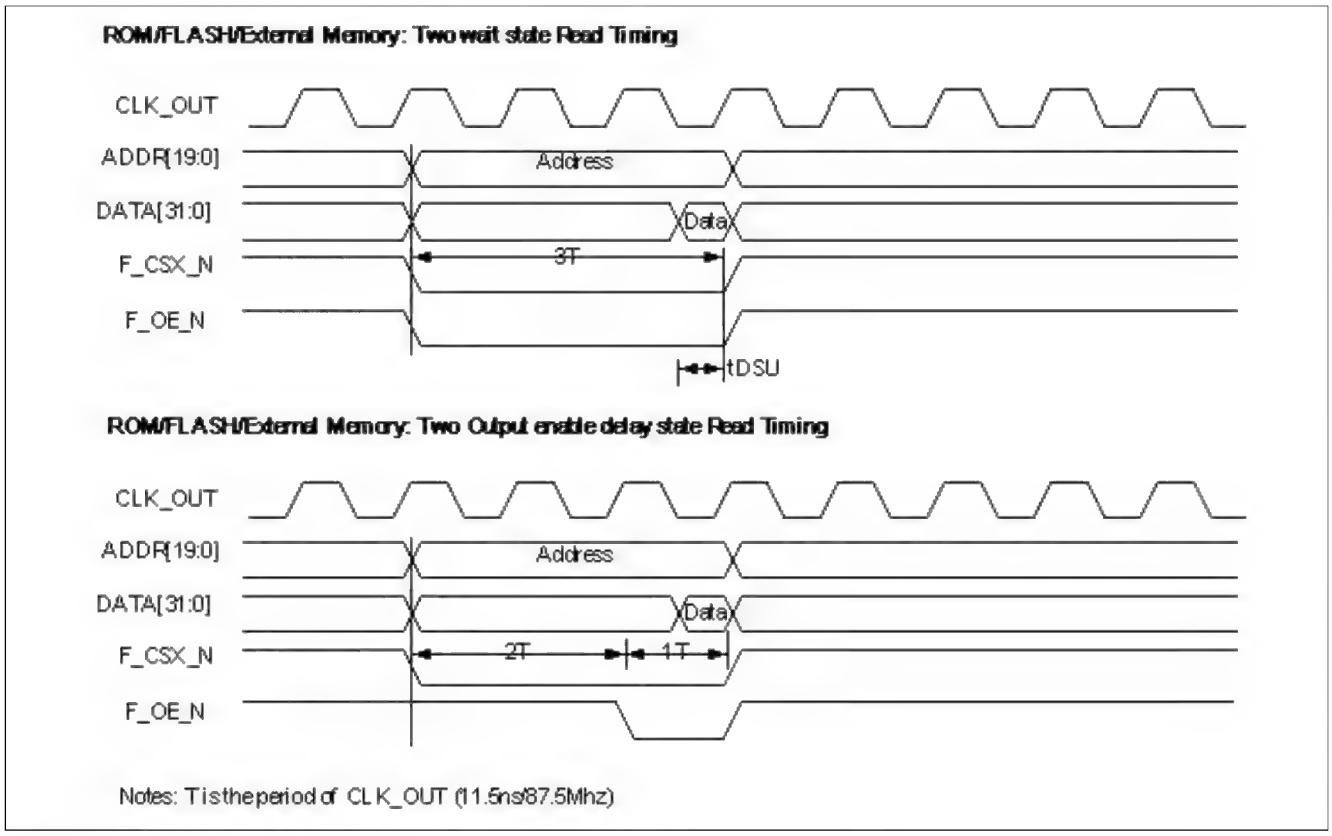


Figure 21 Memory Bus Read Timing

Note: T is the period of CLK_OUT (11.5 ns/87.5 MHz)

Table 52 Memory Bus Read Timing

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Data to CLK_OUT rising setup time	t_{RDSU}	TBD	–	–		–
Data to CLK_OUT rising hold time	t_{RDH}	TBD	–	–		–
Address/F_CSX_N pulse width	t_{AC}	–	(n+1)T	–		–
Address/F_CSX_N to F_OE_N setup	t_{AOE}	–	nT	–		–

9.3.3 Memory Bus Write Timing

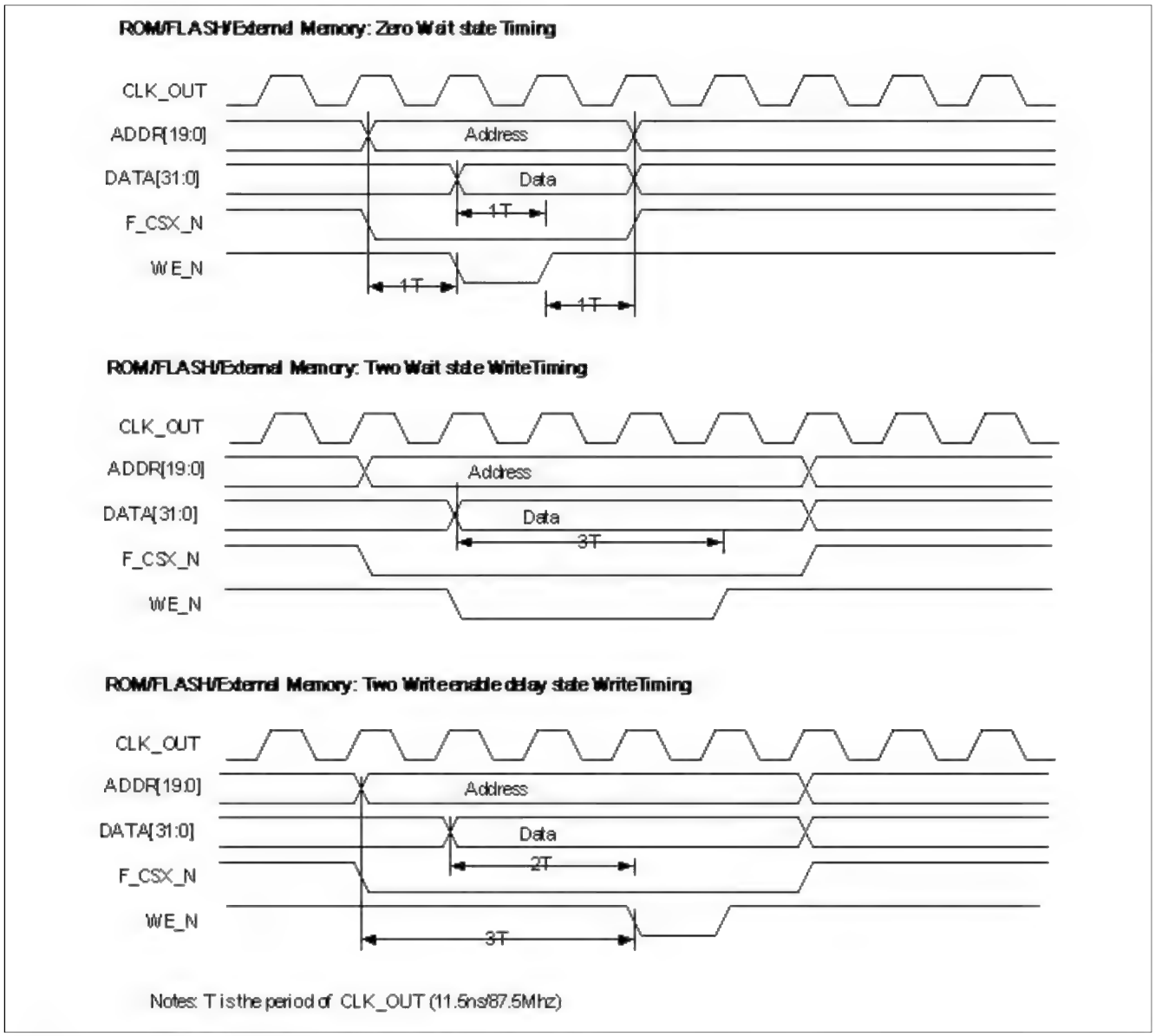


Figure 22 Memory Bus Write Timing

Note: T is the period of CLK_OUT (11.5 ns/87.5 MHz)

Table 53 Memory Bus Write Timing

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Address/CS to WE_N falling setup time	t_{ASU}	–	(n+1)T	–		–
Data to WE_N rising setup time	t_{WDSU}	–	(n+1)T	–		–
Data to WE_N rising hold time	t_{WDH}	–	1T	–		–
WE_N pulse width	t_{WEP}	–	(n+1)T	–		–

10 Package Outlines

10.1 Plastic Quad Flat Package (P-FQFP) 208-pin

Dimensions in mm.

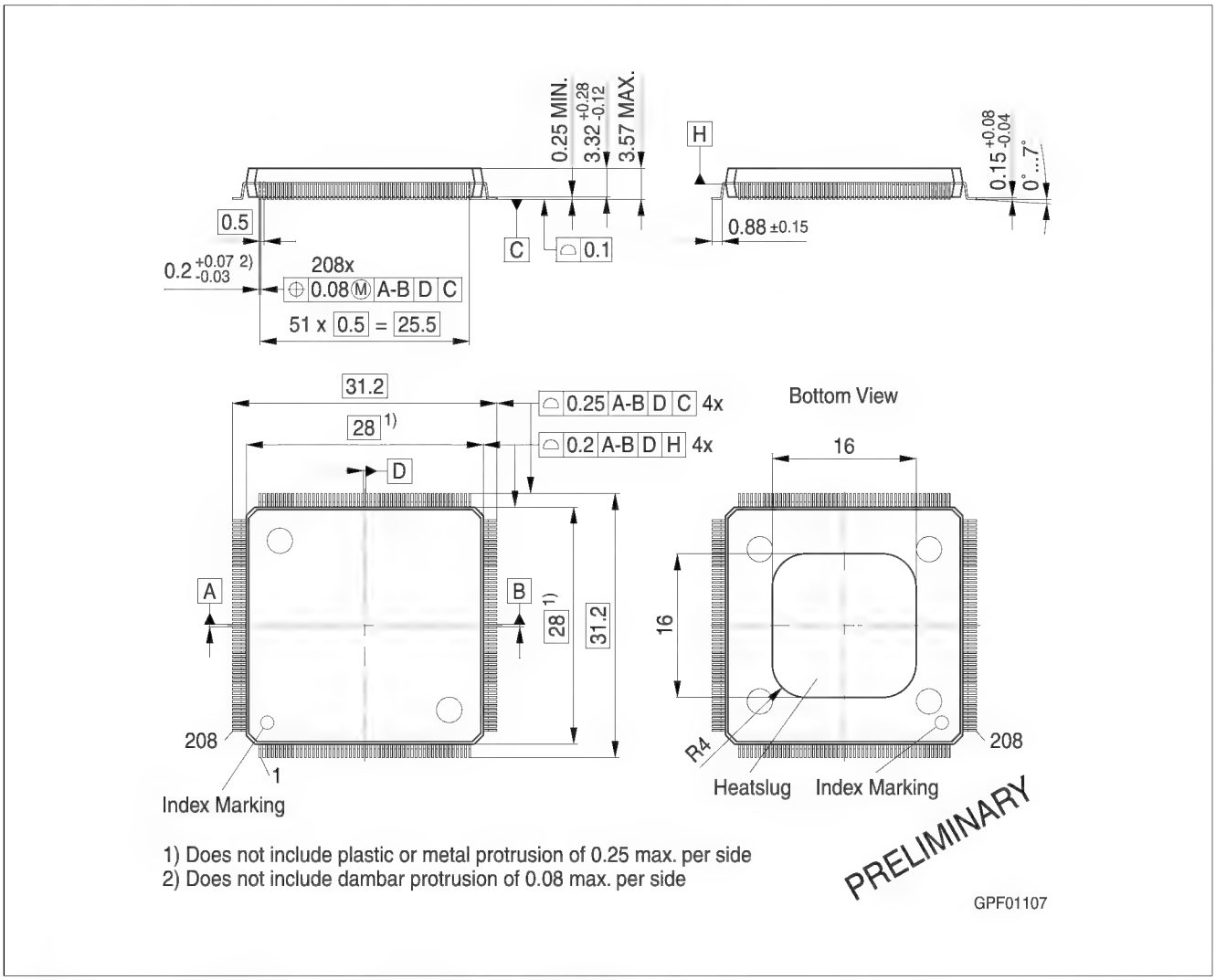


Figure 23 P-FQFP-208-10 (Plastic Quad Flat Package)

Dimensions in mm.

Terminology

A	
AHB	Advance High performance Bus
ALE	Address Latch Enable
AN	Auto-Negotiation
APB	Advanced Peripheral Bus
ASB	Advanced System Bus
ASIC	Application Specific Integrated Circuit
B	
BC	BroadCast
BP	Back Pressure
BPDU	Bridge Protocol Data Unit
BISS	Build In Self test error Skip
BIST	Build In Self Test
C	
CLK	Clock
COL	Collision
CoS	Class of Service
CRC	Cyclic Redundancy Check
CRS	Carrier Sense
CSX	Chip Select for external I/O bank0
D	
DFE	Decision Feedback Equalization
DMA	Direct Memory Access
F	
FC	Flow Control
FIFO	First-In-First-Out
G	
GND	Ground
GPIO	General Purpose I/O
GPIOL	GPIO of groupL
GPIOM	GPIO of groupM
GPSI	General Purpose Serial Interface
H	
HOL	Head-on-Line
I	
INTC	Interrupt Control Registers
INTX	Interrupt for external I/O bank0
IPG	Inter Packet Gap
IRQ	Interrupt ReQuest
J	
JTAG	Joint Test Action Group

L	
LSb	Least Significant Bit
LSB	Least Significant Byte
M	
MAC	Media Access Control
MC	Multicast
MDC	Management Data Clock
MDIO	Management Data I/O
MDI	Medium dependent interface
MDIX	MDI Crossover
MII	Media Independent Interface
MIPS	Million Instructions Per Second
MMU	Memory Management Unit
N	
NAT	Network Address Translation
NRZI	Non Return Zero Invert
NRZ	Non Return Zero
P	
PCS	Physical Coding Sublayer
PHY	PHYsical Layer
PLL	Phase Locked Loop
PMA	Physical Medium Attachment
PMD	Physical medium Dependent
PQFP	Plastic Quad Flat Package
R	
RISC	Reduced Instruction Set Computer
RX	Receive
RXD	Receive Data
RXDV	Receive Data Valid
S	
SA	Source Address
SMC	Flash Control Registers
SW	Switch
SYSC	System Control Registers
T	
TOS	Type Of Service
TX	Transmit
TXC	Transmit Clock
TXE	Transmit Enable
TXD	Transmit Data
U	
UART	Universal Asynchronous Receiver Transmitter
V	

VLAN	Virtual LAN
W	
WAN	Wide Area Networks

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